

ISSN 0006 8241 = Bothalia

Bothalia

A JOURNAL OF BOTANICAL RESEARCH

Vol. 26,1

May 1996



NATIONAL
BOTANICAL
INSTITUTE

TECHNICAL PUBLICATIONS OF THE NATIONAL BOTANICAL INSTITUTE, PRETORIA

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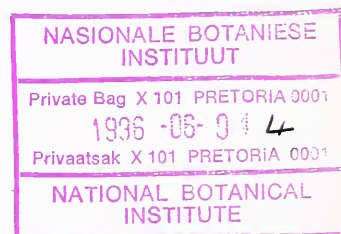


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ISSN 0006 8241

May 1996



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Four new species and one new subspecies of *Lachenalia* (Hyacinthaceae) from arid areas of South Africa

G.D. DUNCAN*

Keywords: Hyacinthaceae, *Lachenalia*, new species, new subspecies, South Africa

ABSTRACT

Four new species of *Lachenalia* are described: *L. karooica* W.F.Barker ex G.D.Duncan from the Great Karoo and southwestern Free State, *L. perryae* G.D.Duncan from the Little Karoo and southern Cape, as well as *L. neilii* W.F.Barker ex G.D.Duncan and *L. alba* W.F.Barker ex G.D.Duncan, both from the Nieuwoudtville-Calvinia District of the Northern Cape. In addition, a new subspecies, *L. marginata* W.F.Barker subsp. *neglecta* Schltr. ex G.D.Duncan is described from the Western Cape.

INTRODUCTION

Lachenalia Jacq. f. ex Murray is the largest genus within the southern African Hyacinthaceae and comprises more than 100 species (Duncan 1988, 1992). The genus is endemic to this region where it has a very wide distribution extending from the southwestern parts of Namibia, southwards throughout Namaqualand, the Western Cape and Great Karoo to as far inland as the southwestern Free State, from where its probable boundary makes an arc to the southeast down to Transkei on the east coast of the Eastern Cape (Barker 1987). Most of the taxonomic work on *Lachenalia* carried out this century has been undertaken by the late Miss W.F. Barker, formerly curator of the Compton Herbarium at Kirstenbosch Botanical Garden. Her studies, both during her term as curator and subsequent to her retirement, have resulted in the publication of more than forty new species for the genus. A number of new *Lachenalia* species have still to be formally described and published, and this paper serves as the first in a series to be published as a continuation of the recent work of W.F. Barker (Barker 1978, 1979, 1983a & b, 1984, 1987, 1989) and the current author (Duncan 1993) towards a revision of the genus.

NEW SPECIES IN LACHENALIA

***Lachenalia karooica* W.F.Barker ex G.D.Duncan**, sp. nov. distinguitur inflorescentia spicata vel subspicata floribus patentibus, oblongo-campanulatis virellis cum vel sine basibus excaeruleis, segmentibus interioribus perianthii recurvatis, staminibus bene exsertis patentibus, plerumque folio singulari lanceolato conduplicato venis longitudinalibus depressis, supra maculis brunneis, viridibus vel marroninis irregulariter dispersis.

TYPE.—Free State, 2925 (Jagersfontein): Fauresmith veld, 0.5 km on road from Fauresmith to Koffiefontein, (–CB), 6–8-1976, *Chaplin s.n.*, (NBG, holo.).

* National Botanical Institute, Kirstenbosch, Private Bag X7, Claremont 7735, Cape Town.
MS. received: 1995-10-09.

Deciduous, winter-growing geophyte 45–220 mm high. *Bulb* globose, 10–20 mm in diam., white with thin brown outer scales, usually produced into a neck terminating just below ground level. *Leaf* usually solitary, occasionally 2, lanceolate, conduplicate, 40–200 × 5–20 mm, glaucous with depressed longitudinal veins on upper surface and a coriaceous margin, and irregularly scattered brown, green or maroon blotches mainly on upper surface; clasping leaf base 5–30 mm long with magenta bands or blotches just below ground level, shading to purplish maroon above ground level. *Inflorescence* spicate or subspicate, few to many-flowered, 20–150 mm long with a short sterile tip; peduncle erect to suberect, 20–80 mm long, slender or sturdy, shorter than length of leaf, mottled with very pale maroon and green; rachis mottled with very pale maroon and green; pedicels absent or up to 2 mm long; bracts ovate, greenish white, 1–2 mm long. *Flowers* patent, oblong-campanulate, dull white to greenish white, often discolouring to a dull purple on herbarium sheets; outer perianth segments oblong, 5–7 × 2–3 mm, with or without bluish bases, with purplish maroon or greenish brown gibbosities; inner perianth segments obovate, recurved, 7–10 × 3 mm, with brownish green keels. *Stamens* well exerted beyond tip of perianth, spreading; filaments white, 10 mm long; anthers pale to dark maroon prior to anthesis, yellow at anthesis. *Ovary* ovoid, pale green, 2–3 mm long; style white, 10 mm long, protruding well beyond stamens as ovary enlarges. *Capsule* ovoid, membranous, 5–7 mm long. *Seed* globose with an arillode with a terminal ridge of medium height. *Chromosome number*: 2n = 16. Figures 1A; 2 & 3.

Etymology: named after the Great Karoo where the first specimens were collected, and from where the largest number of collections are known.

Diagnostic characters

L. karooica is characterised by a spicate or subspicate inflorescence of patent, oblong-campanulate flowers, with the inner perianth segments distinctly recurved and considerably longer than the outer ones. The spreading stamens are well exerted beyond the tip of the perianth, and the anthers are conspicuously pale to dark maroon prior

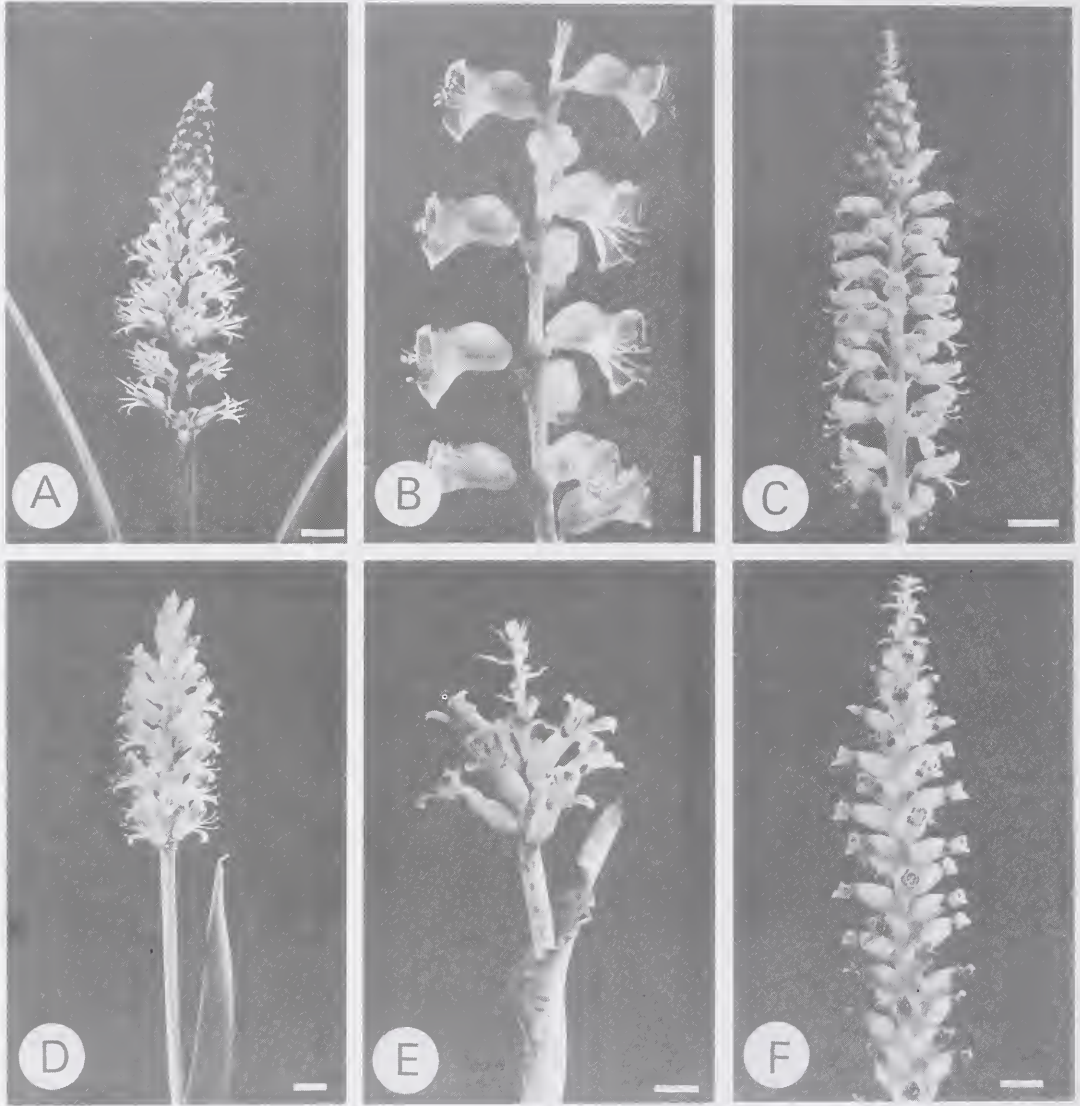


FIGURE 1.—Inflorescences of four new species and one new subspecies of *Lachenalia*. A, *L. karooica*, Chaplin s.n.; B, *L. perryae*, Perry s.n.; C, *L. neilii*, Duncan 196; D, *L. alba*, Steiner 1366; E, *L. marginata* subsp. *marginata*, Duncan 197; F, *L. marginata* subsp. *neglecta*, Duncan 238. Scale bars: 10 mm.

to anthesis. The plant usually has a single lanceolate leaf which is glaucous and distinctly conduplicate, with depressed longitudinal veins on the upper surface, and irregularly scattered brown, green or maroon blotches, mainly on the upper surface.

L. karooica is related to *L. bowkeri* Baker, an as yet poorly known species from the southern part of the Eastern Cape, in that both have a usually single conduplicate, lanceolate leaf and oblong-campanulate, dull white to greenish white, patent flowers which are sessile or have very short pedicels. The anthers of both species are distinctly pale to dark maroon prior to anthesis. *L. bowkeri* differs in having included, declinate stamens, the tips of the outer perianth segments not re-

curved, and the leaf pale green and unblotched without coriaceous margin.

Flowering time: June to September.

Distribution and habitat

Material of this very distinctive species was first collected by Douglas F. Gilfillan in August 1899 in the Mid-delburg District of the Eastern Cape. It has since been recorded from several widely separated localities in the Great Karoo and Northern Cape, and from one locality at Karooport. It is distinguished from all other lachenalias in having a single glaucous, conduplicate, lanceolate leaf with a coriaceous margin, and oblong-campanulate flow-

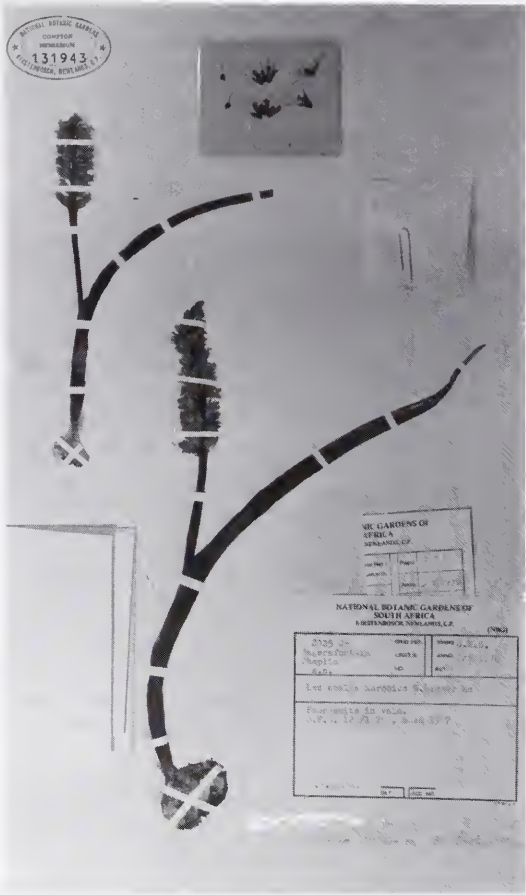


FIGURE 2.—Holotype of *Lachenalia karooica*, Chaplin s.n.

ers with spreading, exerted stamens, of which the anthers are distinctly pale to dark maroon prior to anthesis. The largest number of specimens is recorded from the Fauresmith District in the southwestern part of Free State, and it is very likely that the plant occurs throughout the Great Karoo and much of the Northern Cape; it is no doubt due to the remote nature of this area and the inconspicuousness of the flowers that only a small number of scattered specimens has been recorded. *L. karooica*, although growing in areas with predominantly summer rainfall, follows the typical pattern of winter rainfall growth and summer dormancy characteristic of the vast majority of species belonging to this genus.

At the Fauresmith site, plants occur singly or in small groups on south-facing aspects on dolomite outcrops, often growing in the shade of *Rhus burchellii* Sond. ex Engl. Two other geophytes encountered at this site are the white-flowered *Freesia andersoniae* L.Bolus and the yellow-flowered *Homeria pallida* Baker, both widespread, spring-flowering geophytes which follow the winter growth cycle.

Material examined

NORTHERN CAPE.—2824 (Kimberley): between Campbell and Schmidtsdrif, (–CA), Aug. 1963, *Stayner s.n.* (NBG); Farm Wolwefontein, Barkly West, (–DA), July 1936, *Acocbs 540* (PRE). 2922 (Prieska):

near Prieska, (–DA), Aug. 1935, *Bryant 592* (PRE); Prieska, (–DA), June 1969, *Hardy & Rauh 1591* (PRE). 3025 (Colesberg): Colesberg commonage, (–CA), Aug. 1925, *Botha s.n.* (PRE). 3124 (Hanover): 12.6 km from T-junction on Nieuw Bethesda road to Middelburg, (–DC), Sept. 1990, *Van Jaarsveld 11160* (NBG).

FREE STATE.—2925 (Jagersfontein): Fauresmith Botanical Reserve, (–CB), Aug. 1938, *Henrici 3158* (PRE); Sept. 1925, *Pole Evans 1825* (PRE); Sept. 1925, *Smith 404* (PRE); 0.5 km on road from Fauresmith to Koffiefontein, (–CB), Aug. 1976, *Chaplin s.n.* (NBG); Aug. 1993, *Duncan 367* (NBG); Aug. 1976, *Lumley s.n.* (NBG).

EASTERN CAPE.—3125 (Steensburg): Farm Conway, Middelburg Dist., (–CB), Aug. 1899, *Gilfillan s.n. in Herb. Galpin 5578* (PRE). 3225 (Somerset East): Mountain Zebra National Park, top of Babylon's Tower, (–AB), Aug. 1963, *Liebenberg 7248* (PRE).

WESTERN CAPE.—3319 (Worcester): Karooopoot, (–BC), Aug. 1980, *Karoo National Botanic Gardens expedition s.n.* (NBG).

***Lachenalia perryae* G.D. Duncan, sp. nov.** distinguatur inflorescentia racemosa floribus oblongo-campanulatis segmentibus exterioribus perianthii pallide azureis declinatis, staminibus inclusis, folio singulari arcuato conduplicato anguste lanceolato infra fasciis perspicuis viridibus vel magenteis.

TYPE.—Western Cape, 3319 (Worcester): Karoo National Botanic Garden veld reserve, Worcester, (–CB), Aug. 1985, *P.L. Perry s.n.* (NBG, *holo.!*; PRE).

Deciduous, winter-growing geophyte 120–320 mm high. *Bulb* globose, 10–20 mm in diam., covered with dark brown spongy tunics produced into a short neck terminating just below ground level. *Leaf* usually solitary, occasionally 2, 240–300 × 10–23 mm, arcuate, conduplicate, narrowly lanceolate, yellowish green, banded below with dark green shading to maroon or magenta on the pale white clasping leaf base. *Inflorescence* subspicate or racemose, lax, few to many-flowered, up to 130 mm long with a very short sterile tip; peduncle slender, suberect, up to 260 mm long, pale green; pedicels 2–3 mm long; bracts ovate to lanceolate, greenish white, 1–2 mm long. *Flowers* patent or slightly cernuous, oblong-campanulate; outer perianth segments oblong, very pale blue, 5–6 × 3 mm, with pale green or brown gibbosities; inner perianth segments obovate, obtuse, 7–9 × 4–5 mm, protruding well beyond outer perianth segments, pale white to whitish yellow with green keels and recurved tips. *Stamens* declinate;

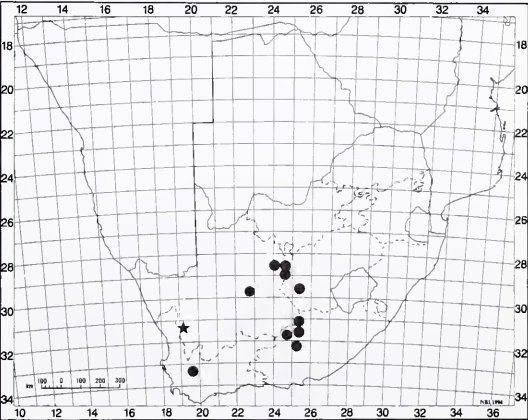


FIGURE 3.—Distribution of *Lachenalia karooica*, ●; and *L. neilii*, ★.



filaments white, as long as or very slightly longer than inner perianth segments. *Ovary* globose, pale green, 2 mm long; style white, 8–10 mm long, protruding well beyond stamens as ovary ripens. *Capsule* globose, 5–7 mm long. *Seed* globose with an arillode with a terminal ridge of medium height. Figures 1B; 4 & 5.

Etymology: *L. perryae* is named after Miss Pauline

tanical Gardens at Worcester, in recognition of her valuable work in collecting and recording the bulbous flora of the Little Karoo.

Diagnostic characters

Superficially, *L. perryae* is reminiscent of the very variable and widespread *L. unifolia* Jacq., to which it is related due to the combination of features of a single narrow, banded leaf, patent or slightly cernuous, oblong-campanulate flowers with pale blue outer perianth segments and whitish inner segments, and included stamens. It differs mainly in leaf morphology, and to a lesser extent, in pedicel length, flower shape and seed morphology. In *L. unifolia*, which never has more than one leaf, the leaf blade is linear, widening abruptly into a loosely clasping base. *L. perryae*, on the other hand, usually has a single leaf, or occasionally two, with a narrowly lanceolate blade which does not widen abruptly. Furthermore, the flowers of *L. perryae* have short pedicels no longer than 3 mm, whereas *L. unifolia* usually has very long pedicels up to 12 mm long. Although both these species have oblong-campanulate flowers, the perianth segments of *L. unifolia* are usually appreciably longer and the tips of the inner perianth segments of *L. perryae* considerably more flared than in *L. unifolia*. In addition, the seed of *L. perryae* has an arillode with a terminal ridge of medium height, whereas in *L. unifolia* the arillode is almost obsolete.

Flowering time: July to September.

Distribution and habitat

The first specimens of *L. perryae* were collected by Miss W.F. Barker in August 1949 near Robertson in the Little Karoo, and it is from this region that most records of the species are known; the largest number of collections have been made in the veld reserve of the Karoo National Botanical Garden at Worcester. The species is currently known from the Worcester District in the north to Port Beaufort in the south and eastwards to Albertinia, all in the Western Cape, with one isolated record much further east near Kommadagga in the Eastern Cape. It occurs in arid areas in clay or sandy soil amongst succulents, usually on south-facing aspects. Plants occur singly or in small groups, and are locally common in some areas. It is quite a variable species as

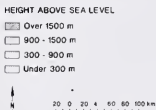


FIGURE 5.—Distribution of *Lachenalia perryae*, ●; and *L. alba*, ★

regards plant size, ranging from depauperate specimens 120 mm high to much taller individuals, up to 320 mm in height.

Material examined

WESTERN CAPE.—3319 (Worcester): top of Hex River Pass, (–BD), Sept. 1974, *Maue 221* (NBG); Karoo National Botanical Garden veld reserve, (–CB), Sept. 1949, *Barker 5941* (NBG); Aug. 1970, *Bayer 17* (NBG); Aug. 1953, *Compton 24118* (NBG); Aug. 1962, *Olivier 59* (NBG); Aug. 1986, *Perry s.n.* (NBG); De Doorns Mountains on way to Touws River, (–CB), Aug. 1984, *Van Zijl 235* (NBG); near Nuy cement factory, (–DA), Aug. 1970, *Barker 10706* (NBG); 9 km beyond Nuy Village, (–DA), Sept. 1975, *Thomas s.n.* (NBG); 0.3 km from Breede River Bridge on road to Le Chasseur, (–DC), Aug. 1974, *Van Reenen s.n.* (NBG); near Robertson, (–DD), Aug. 1949, *Barker 5393* (NBG). 3419 (Caledon): 17 km E of Caledon, (–BA), Aug. 1969, *Barker 10616* (NBG). 3420 (Bredasdorp): 20 km NW of Port Beaufort on Malagas road, (–BD), Aug. 1962, *Thomas s.n.* (NBG). 3421 (Riversdale): 1.6 km along Stilbaai road from Albertinia, (–BA), Aug. 1971, *Thomas s.n.* (NBG).

EASTERN CAPE.—3325 (Port Elizabeth): road to Jansenville from Kommadagga, (–BB), Sept. 1973, *Bayliss 5919* (NBG, PRE).

***Lachenalia neilii* W.F. Barker ex G.D. Duncan**, sp. nov. distinguitur inflorescentia multiflora racemosa floribus parvis oblongo-campanulatis pallide viridibus basibus perspicuis obscure caeruleis, tumoribusque clare viridibus vel brunneis, staminibus declinatis, foliis duobus lanceolatis glaucis suberectis innotatis supra venis longitudinalibus depressis annuloque bulbillorum basi bulbi.

TYPE.—Northern Cape, 3119 (Calvinia): Nieuwoudtville–Calvinia road (R27), at turnoff to Rondekop, in ditches on both sides of road, (–AC), 12-9-1985, *G.D. Duncan 196* (NBG, holo.).

Deciduous, winter-growing geophyte 120–320 mm high. *Bulb* globose, 12–25 mm in diam., surrounded by strong, dark brown outer tunics, usually with a ring of bulbils produced at the base. *Leaves* 2, lanceolate, glaucous, unmarked, suberect, with depressed longitudinal veins on upper surface, 55–145 × 7–22 mm, clasping leaf base pale yellowish green, with or without tiny maroon speckles, 40–70 mm long. *Inflorescence* racemose, many-flowered, 50–150 mm long with few sterile flowers at tip; peduncle erect, sturdy, pale green, with or without pale brown or maroon speckles, 40–110 mm long; pedicels suberect, white, 2–5 mm long; bracts ovate to lanceolate, white, 2–3 mm long. *Flowers* oblong-campanulate, greenish white fading to dull red, with distinct dull blue bases; outer perianth segments oblong, 7–8 × 4 mm, greenish white with distinct dull blue bases and bright green or brown gibbosities; inner perianth segments obovate, tips slightly recurved, protruding beyond outer perianth segments, white with green keels, 9–10 × 4–5 mm. *Stamens* declinate; filaments white, exserted up to 2 mm beyond perianth, 9–11 mm long. *Ovary* ovoid, bright green, 3 mm long; style white, 8–11 mm long. *Capsule* ovoid, 7–8 × 5–6 mm. *Seed* globose, with an arillode with a terminal ridge of short to medium height. Figures 1C; 3 & 6.

Flowering time: August to October.

Etymology: *L. neilii* is named after Mr Neil Macgregor of Glen Lyon Farm, Nieuwoudtville, in recognition of the sterling nature conservation work he has done in this area

of the Northern Cape. This is the second *Lachenalia* species commemorating Mr Macgregor and his family; in 1979, the very rare *L. macgregoriorum* W.F.Barker was described from the Charles Hoek area of Nieuwoudtville.

Diagnostic characters

L. neilii is characterised by a many-flowered raceme of greenish white oblong-campanulate flowers with distinct dull blue bases and bright green or brown gibbosities, shortly exserted stamens, two glaucous, lanceolate leaves and usually a ring of bulbils produced at the base of the bulb. It is related to *L. alba* W.F.Barker ex G.D.Duncan due to the shared features of two lanceolate, unmarked leaves, the oblong-campanulate flowers with protruding white inner perianth segments and the slightly exserted stamens. *L. alba* differs in having bigger, more campanulate flowers which are pure white, without distinct dull blue bases, and which are usually attached to the rachis by very short pedicels. Furthermore, the bulb of *L. alba* does not develop a ring of bulbils at its base as *L. neilii* does.

Distribution and habitat

L. neilii has a restricted distribution in the Nieuwoudtville and Calvinia Districts of the Northern Cape



FIGURE 6.—Holotype of *Lachenalia neilii*, Duncan 196.

where it grows in heavy red clayey soil on open flats. The first specimens were collected as far back as September 1930 by a National Botanic Gardens expedition in the area known as Klipkoppies in the Nieuwoudtville area. The plant is locally plentiful and has been recorded as growing in association with another new species, *L. alba*, which is also published for the first time in this paper, and which is also restricted to the Nieuwoudtville area in the Calvinia District.

Material examined

NORTHERN CAPE.—3119 (Calvinia): Klipkoppies, Nieuwoudtville, (–AC), Aug. 1961, *Barker 9535* (NBG); Sept. 1961, *Barker 9667* (NBG); Sept. 1986, *Brandham 3018* (NBG); Sept. 1930, *National Botanic Gardens expedition s.n.* (BOL); Glen Lyon Farm, Nieuwoudtville, (–AC), Oct. 1967, *Barker 10544* (NBG); Oct. 1973, *Barker 10892* (NBG); Glen Ridge Farm, Nieuwoudtville, (–AC), Aug. 1960, *Barker 9185* (NBG); Aug. 1961, *Barker 9435* (NBG); Aug. 1968, *Thomas s.n.* (NBG); 1.6 km E of Nieuwoudtville on road to Calvinia, (–AC), Nov. 1967, *Barker 9532* (NBG); Nieuwoudtville Reserve, (–AC), Oct. 1983, *Perry & Snijman 2420* (NBG); Nieuwoudtville-Calvinia road (R27), at Rondekop turnoff, (–AC), Sept. 1985, *Duncan 196* (NBG). Without precise locality: Klipbokberg, March 1931, *Herre s.n.* (BOL); Leliefontein, Sept. 1940, *Leipoldt 3386* (BOL).

***Lachenalia alba* W.F.Barker ex G.D.Duncan**, sp. nov. distinguitur inflorescentia subspicata vel racemosa floribus grandibus oblongo-campanulatis candidis cum vel sine basibus perpallide azureis cum vel sine carinis distinctis viridibus, rubris vel caeruleis segmentibus interioribus perianthii recurvatis declinatis, staminibusque breviter exsertis, foliis duobus lanceolatis suberectis ad erectis glaucis innotatis supra venis longitudinalibus depressis.

TYPE.—Northern Cape, 3119 (Calvinia); Charles Hoek, Nieuwoudtville, (–AC), 30-9-1973, *W.F. Barker 10888* (NBG, holo.!).

Deciduous, winter-growing geophyte 100–330 mm high. *Bulb* globose, 15–20 mm in diam., white with thick membranous dark brown outer tunics. *Leaves* 2, lanceolate, channelled above, suberect to erect, glaucous, unmarked, margin sometimes undulate, upper leaf surface with depressed longitudinal veins, 120–230 × 15–25 mm, clasping leaf base 20–80 mm long, sometimes suffused with dull maroonish brown zones. *Inflorescence* subspicate to racemose, usually many-flowered, 40–170 mm long with short sterile tip; peduncle suberect to erect, pale green, 50–150 long; rachis pale green shading to white in upper half, with very pale maroonish brown speckles; pedicels white, 1–3 mm long; bracts white, ovate to lanceolate, 2–3 mm long. *Flowers* pure white, oblong-campanulate; outer perianth segments oblong, 7–8 × 3–4 mm, with or without very pale greenish blue bases, gibbositities pale brownish green or dull red; inner perianth segments protruding well beyond outer perianth segments, recurved, obovate, 10–11 × 4–6 mm, with or without pale to distinct brownish green, red or blue keels. *Stamens* declinate; filaments white, 10 mm long, protruding up to 2 mm beyond tip of perianth. *Ovary* ovoid, pale green, 3–4 mm long; style white, 8 mm long, protruding well beyond perianth as ovary matures. *Capsule* ovoid, pale green, 7 mm long. *Seed* globose with an arillode with a terminal ridge of medium height. Figures 1D; 5 & 7.

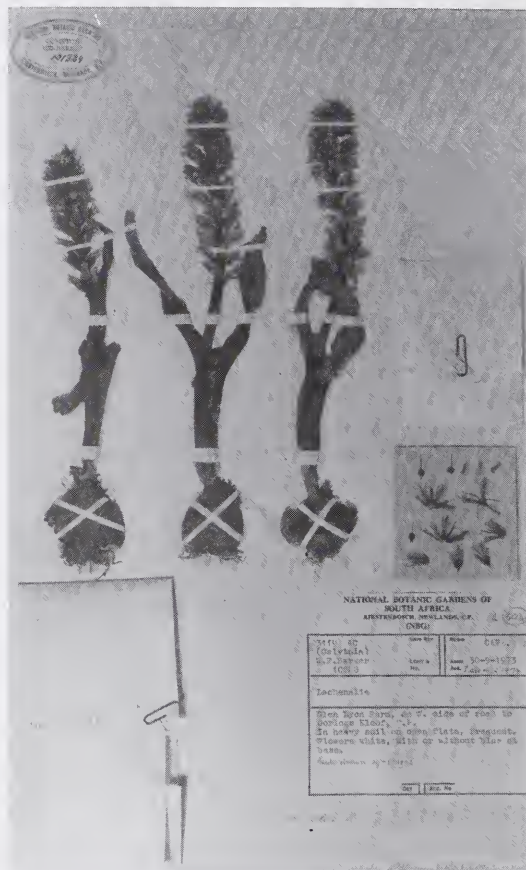


FIGURE 7.—Holotype of *Lachenalia alba*, Barker 10888.

Flowering time: August to October.

Etymology: named *alba* due to the overall white colouring of the flowers.

Diagnostic characters

L. alba is characterised by its many-flowered inflorescence of pure white, oblong-campanulate flowers with recurved inner perianth segments which may or may not have distinct green, red or blue keels, and its two glaucous, lanceolate, suberect to erect unmarked leaves with distinct, depressed longitudinal veins on the upper surface. It is related to *L. neilii*, but the latter differs in having smaller, less campanulate greenish white flowers with distinct dull blue bases borne on long pedicels up to 5 mm long, whereas *L. alba* has short pedicels usually not longer than 2 mm. Furthermore, the bulb of *L. alba* does not develop the typical ring of bulbils at its base as *L. neilii* does.

Distribution and habitat

As with *L. neilii*, this species has a restricted distribution in the Nieuwoudtville and Calvinia areas of the Northern Cape, growing in colonies in heavy red clayey

soil on open flats. The earliest record of the plant is the collection made by W.F. Barker in September 1930 at Klipkoppies, Nieuwoudtville. *L. alba* is recorded as growing in association with *L. neilii* and *L. elegans* W.F. Barker, the latter being a very common, variable species in the Nieuwoudtville-Calvinia area, but to my knowledge there are no reports of interspecific natural hybrids between these species.

Material examined

NORTHERN CAPE.—3119 (Calvinia): Klipkoppies, Nieuwoudtville, (–AC), Sept. 1930, *Barker s.n.* (BOL); Sept. 1961, *Barker 9540* (NBG); Sept. 1973, *Barker 10889* (NBG); Sept. 1986, *Brandham 3027* (NBG); 2 km E of Nieuwoudtville, (–AC), Sept. 1957, *Acocks 19493* (NBG); Sept. 1961, *Barker 9532* (NBG); Nieuwoudtville, (–AC), Sept. 1938, *Buhr s.n.* (NBG); Grasberg, (–AC), Sept. 1943, *Buhr s.n.* (NBG); 1 km W of Nieuwoudtville, (–AC) Sept. 1986, *Brandham 3007* (NBG); Oorlogskloof, (–AC), Sept. 1939, *Leipoldt s.n.* (NBG); Oorlogskloof road, 10.6 km S of junction with R27 at Nieuwoudtville, (–AC), Sept. 1986, *Steiner 1366* (NBG); Nieuwoudtville Reserve, (–AC), Sept. 1983, *Perry & Snijman 2369* (NBG); Glen Lyon Farm, (–AC), Aug. 1972, *Barker 10544* (NBG); Sept. 1973, *Barker 10888* (NBG); Oct. 1974, *Barker 10921* (NBG); between Oorlogskloof and Papkuilsfontein, (–AC), Sept. 1939, *Leipoldt 4170* (BOL); near Toren Farm, (–BC), Oct. 1974, *Thomas s.n.* (NBG); 8.2 km along Toren road from Calvinia-Loeriesfontein road, (–BC), Sept. 1986, *Brandham 3030* (NBG). Without precise locality: between Vanrhynsdorp and Calvinia, Sept. 1934, *Bishop S. Lavis s.n.* (BOL).

***Lachenalia marginata* W.F.Barker** in *Journal of South African Botany* 45: 204–207 (1979).

TYPE.—Nieuwoudtville, *Barker 6463* (NBG, holo.).

L. marginata is a very distinctive species with a distribution range extending from the fynbos on the Nieuwoudtville escarpment to the Gifberg massif and the Nardouw-Pakhuis-Cederberg Mountains and the low-lying areas around Clanwilliam where it usually occurs in very sandy soil growing singly or in small groups. The subsp. *marginata*, which is the most widespread of the two subspecies, is recognised by its single ovate leaf with a distinctive thickened coriaceous margin which is undulate and crisped, its heavily banded clasping base and its long, sessile narrowly urceolate flowers with very conspicuous dark brown gibbositities on the outer perianth segments. The seed places the species into the group of species having a medium-sized terminal inflated arillode (Figures 1E; 8 & 9).

Material of subsp. *marginata* examined

NORTHERN CAPE.—3119 (Calvinia): Glenridge Farm, Nieuwoudtville, (–AC), Aug. 1961, *Barker 9433* (NBG); Aug. 1966, *Barker 10451* (NBG); Sept. 1985, *Duncan 197* (NBG); 4.8 km W of Nieuwoudtville, (–AC), Aug. 1950, *Barker 6465* (NBG); July 1948, *Lewis 2408* (SAM); Aug. 1950, *Lewis 3240* (SAM); 6.4 km W of Nieuwoudtville, (–AC), Aug. 1950, *Barker 6463* (NBG).

WESTERN CAPE.—3118 (Vanrhynsdorp): Matzikamma, (–AB), July 1940, *Martin s.n. sub NBG 72364* (NBG); Klawer, (–DC), June 1950, *Barker 7387* (NBG); 3218 (Clanwilliam): 10 km E of Clanwilliam on Pakhuis Pass, (–BB), Sept. 1985, *Duncan 194* (NBG); Aug. 1974, *Nordenstam & Lundgren 1327* (NBG); 3219 (Wuppertal): Lorraine Farm, N of Pakhuis Pass, (–AA), July 1965, *Siaens s.n. sub NBG 84814* (NBG); Matjiesrivier, Cederberg, (–AC), Sept. 1942, *Wagener 209* (NBG).

***Lachenalia marginata* W.F.Barker subsp. *neglecta* Schltr. ex G.D.Duncan**, subsp. nov. a subspecie typica inflo-

rescentia densiore elongata spicata floribus multo parvioribus anguste urceolatis, folioque erecto ad suberecto conduplicato lanceolato ad ovato-lanceolato differt.

TYPE.—Western Cape, 3218 (Clanwilliam): Die Berg Farm, SW of Clanwilliam, (–BB), 18-9-1966, *Barker 10428* (NBG, holo.).

Deciduous, winter-growing geophyte 110–280 mm high. *Bulb* globose, 11–25 mm in diam., white with thin membranous outer tunics. *Leaf* lanceolate to ovate-lanceolate, erect to suberect, almost always solitary (occasionally 2), glaucous, conduplicate, margin coriaceous, dark maroon, undulate and crisped, upper leaf surface with depressed longitudinal veins and irregularly scattered pale to dark green spots, 45–200 × 18–30 mm; tightly clasping leaf base distinctly banded or blotched with dark maroon. *Inflorescence* spicate, dense, many-flowered 45–185 mm long, with several sterile flowers at tip; peduncle 40–150 mm long, erect to suberect, pale green with maroon blotches, thickening towards base of inflorescence; bracts white, ovate to lanceolate, 3–5 mm long. *Flowers* sessile, narrowly urceolate, greenish yellow fading to dull red; outer perianth segments oblong, 6–8 × 3–4 mm, pale greenish yellow with minute blue speckles and conspicuous dark brown gibbositities; inner perianth segments protruding well beyond outer segments, obovate, 7–11 × 4–5 mm, dark greenish yellow, two upper lateral seg-

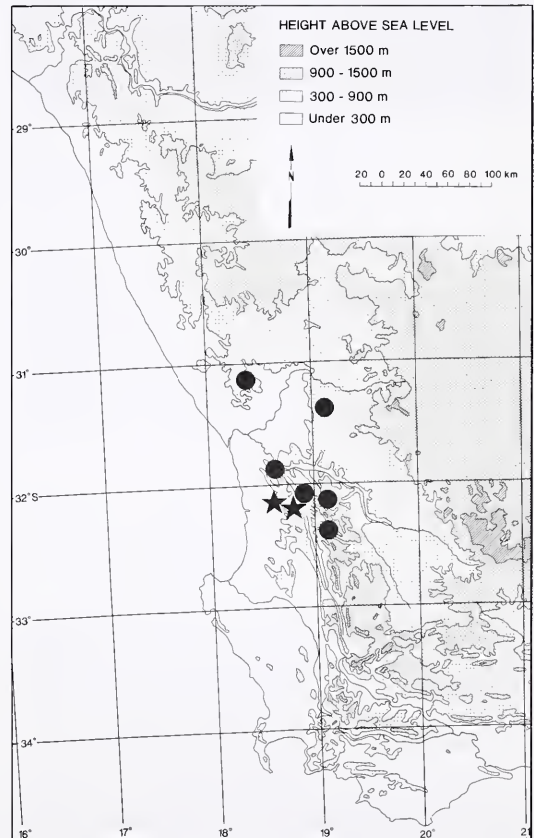


FIGURE 8.—Distribution of *L. marginata* subsp. *marginata*, ●; and *L. marginata* subsp. *neglecta*, ★.

variable and widespread species which is common in this area, but which flowers a few weeks later than *L. marginata* subsp. *neglecta*.

Material examined

WESTERN CAPE.—3218 (Clanwilliam): Zeekoe Vlei Farm, 14 km W of Clanwilliam, (–BA), Aug. 1896, *Schlechter 8490* (B, BM, BOL, G, GRA, K, L, PRE, S, Z); Die Berg Farm, (–BB), Aug. 1966, *Barker 10428* (NBG); 41 km on N7 road Citrusdal-Clanwilliam, (–BB), July 1986, *Duncan 238* (NBG); July 1993, *Duncan 365* (NBG).

ACKNOWLEDGEMENTS

This paper is dedicated to Miss W.F. Barker who died on 27th December, 1994. I am very much indebted to the staff of the Compton Herbarium, especially Dr D.A. Paterson-Jones, Mr J.P. Roux and Mrs S.E. Foster for their assistance at various stages of this study. I also thank Dr O.A. Leistner for compiling the Latin translations of the diagnoses, Mrs J. Loedolff for taking the photographs of the herbarium sheets, Mrs A. Romanowski for producing the black and white photographs from colour slides and Mr M. Lumley for assistance in the field.

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Saxicolous species of the genus *Rinodina* (lichenized Ascomycetes, Physciaceae) in southern Africa

M. MATZER* and H. MAYRHOFFER*

Keywords: biogeography, flora, lichenized Ascomycetes, Physciaceae, *Rinodina*, southern Africa, taxonomy

ABSTRACT

A revision of saxicolous species of the genus *Rinodina* (Ach.) Gray (lichenized Ascomycetes, Physciaceae) in southern Africa is presented. The study area covers the following countries: Angola, Namibia, Republic of South Africa, Lesotho, Swaziland, Zimbabwe, and Mozambique. Fifteen *Rinodina* species are treated in detail, and three of them are new to science: *Rinodina longisperma* Matzer & H. Mayrhofer, *R. scabridula* Matzer & H. Mayrhofer, and *R. striatitunicata* Matzer & H. Mayrhofer. The general part of the study includes information on the most important characters of the species with a special focus on ascospore types and ontogeny, and biogeographical notes are also given. A key to the species is provided. All the species are described in detail with notes on their ascus characters, spermatogonial apparatus, and chemical characteristics, and their substrate and general distribution are indicated. The descriptions are accompanied by illustrations of the ascospores. Except for *Rinodina oxydata* s.l., the distribution of all the species in southern Africa and other parts of Africa respectively, is mapped. Several names were referred into synonymy, including *Rinodina almbornii* H. Mayrhofer, a synonym of *R. confragosula* (Nyl. in Cromb.) Müll. Arg., and *R. depressa* (Vain.) Zahlbr. and *R. albicans* H. Mayrhofer which are synonymous to *R. huillensis* Vain. A separate section encompasses nine excluded species.

INTRODUCTION

The cosmopolitan genus *Rinodina* (Ach.) Gray comprises about two hundred species (Hawksworth *et al.* 1983), and its species taxonomy is still not settled satisfactorily, particularly in the southern hemisphere. This became obvious, once again, during the preparation of the present work, a re-assessment of saxicolous species occurring in southern Africa. Type material of all critical species and, to the best of our knowledge, almost all relevant collections were examined. Nevertheless, the present study should be seen as an actual inventory rather than an ultimate revision. Given the vastness of the study area, there are relatively few collections of saxicolous *Rinodina* species, and most of them come from the Cape Province in the Republic of South Africa. Type specimens of some species are scant or damaged, several species are still known from a few collections only, and thus the extent of their variation is difficult to estimate. This is particularly problematical in cases where species which are separated by slight morphological differences only, have been described. Morphologically and chemically, many of the saxicolous *Rinodina* species in southern Africa do not exhibit 'exciting characters', and great similarities can be observed between several species. Therefore, determination of specimens has often proved to be rather difficult. In the material studied, several *Rinodina* species were detected which are most probably undescribed. Not all of them are included in the present study, as they are often known from a single locality only, and their relationships to already described and similar species could not be resolved.

However, despite the problems indicated above, many new results are presented in this paper. Several names of

taxa are referred into synonymy, and three new species are introduced. The importance of minute characters such as ascospore ornamentation and length of spermatia for the circumscription of single species is documented. The first data on the biogeographical affinities of saxicolous *Rinodina* species occurring in southern Africa are presented.

MATERIAL AND METHODS

Standard light microscope techniques and standard tests for thallus chemistry (tlc, spot tests for colour reactions) were employed. Descriptions of ascus apices are based on observations in dilute original Lugol's solution (MERCK 9261) without pretreatment with KOH (K). For the testing of the N (= HNO₃)-reaction of the blue-green to blackish pigment, longitudinal sections of thalli, apothecia, and/or spermatogonia respectively, were directly mounted in this medium.

THE STUDY AREA

The main focus of this study was on species occurring in extratropical southern Africa, mainly including Namibia, the Republic of South Africa, Lesotho, and Swaziland. Some specimens from adjacent countries (Angola, Zimbabwe, Mozambique) were also studied. However, as already mentioned above, most of the specimens examined were from the Republic of South Africa, mainly from the Cape Province. For comparative purposes it was also necessary to study saxicolous *Rinodina* species described or mentioned from other parts of Africa, mainly including the islands of Pagalu (Annobón) and São Tomé & Príncipe in the Atlantic Ocean, and the island of Socotra in the Indian Ocean.

* Institute for Botany, Karl-Franzens-University Graz, Holteigasse 6, A-8010 Graz, Austria.
MS. received: 1995-03-15.

MORPHOLOGY, ANATOMY AND CHEMISTRY

A short survey is given here of the most important characters of the species treated in detail.

Thallus and prothallus

Thalli in *Rinodina* species are usually crustose or crustose to squamulose. The formation of blastidia is the most important character for the separation of *R. scabridula*. The presence or absence of a distinct prothallus should not be overestimated in the circumscription of species.

Chemistry

Only a few species contain secondary lichen substances which are detectable by thin-layer chromatography (tlc). *Rinodina huillensis* is the only species with gyrophoric acid (and, in part, other secondary compounds) and is well characterized by the C+ red reaction in the medulla of the thallus. The thalli of *R. confragosa*, *R. oxydata* s.l., and *R. substellulata* give a K+ yellow reaction. The main lichen compound in these taxa is atranorin.

Pigments

A blue-green to blackish pigment was often found to be located in parts of the thallus, apothecia (proper exciple, epihymenium), and/or in the spermogonia of six species: *R. confragosa*, *R. huillensis*, *R. oxydata* s.l., *R. striatitunicata*, *R. substellulata*, and *R. subtristis*. The pigment reacts N+ red, K-, and HCl+ blue after pretreatment with K. It is most probably identical to the pigment which was described as 'Lecideagrün' by Bachmann (1890), and it occurs also in other genera of the Physciaceae, e.g. in *Buellia* De Not. (Scheidegger 1993, as 'pigment A').

An interesting and unique character is the K+ yellowish to orange reaction in the hypothecium, the epihymenium (here not always), and in spermogonia (not always) of *R. reagens*, which is due to the presence of a green-yellow pigment.

Apothecia

In the genus *Rinodina*, a great variation in apothecial types can be observed, and even within single species or specimens, the formation of apothecia can be variable. Apothecia are cryptolecanorine, lecanorine (in addition to the thalline margin a proper margin may be developed), and/or lecideine. Apothecia which appear to be lecideine in surface view may contain (dead) algal cells in the exciple (e.g. in *R. oxydata* s.l., *R. subtristis*, *R. teichophioides*).

Asci

Most of the species have asci which can be described as corresponding to the Lecanora type (compare e.g. Honegger 1978; Rambold *et al.* 1994), but some variation in the formation of ascus tips can be observed. In *R. oxydata* s.l., the asci correspond to the Lecanora type but

show tendencies towards the Bacidia type (see e.g. Hafellner 1984; Rambold *et al.* 1994). The axial body in several species is often more or less indistinct (e.g. in *R. geesteranii*, *R. huillensis*, *R. longisperma*, *R. oxydata* s.l., *R. subtristis*) or even not observable (e.g. in *R. longisperma*) under the light microscope. In *R. huillensis*, the axial body may be surrounded by a tube-like structure, and the same phenomenon could be observed in several other species after pretreatment with KOH.

Ascospores

The most important characters for the separation and identification of *Rinodina* species are those of the ascospores. For terms used in the description of ascospores occurring in *Rinodina* (and other genera of the Physciaceae) see Poelt & Mayrhofer (1979); revised compilations of ascospore types were published by Hafellner *et al.* (1979), Mayrhofer & Poelt (1979) and Mayrhofer (1982, 1984a). With the increasing knowledge on possible formation types in the ascospores of Physciaceae, it became necessary to modify the classification systems for spores by subsequent authors. For a better understanding, the most important changes are briefly outlined here.

1. The presence vs. absence of a torus (i.e. a dark belt in the region of a spore septum) is not always a reliable character for the definition of spore types. For instance, within several species a torus can clearly be observed in some of the ascospores under the light microscope, but is indistinct or even not visible in others (e.g. in *Rinodina fimbriata*, *R. microlepidea*, *R. striatitunicata*, *R. substellulata*); the same has been reported for other genera and species of the Physciaceae (e.g. *Amandinea petermannii*; see Matzer *et al.* 1994b). Scheidegger (1993: 333) pointed out that within *Buellia* closely related species may differ considerably in their torus while, on the other hand, species with only slight affinities to each other may have a similar torus. Consequently, a distinction of spore types which is solely based on the presence or absence of a torus cannot be recommended. This mainly concerns the following ascospore types: Beltramia type (incl. Buellia type) and Physconia type (incl. Dubyana and Sricula type); in both cases the terms which have been introduced first into the literature should be used (for dates of introduction see Mayrhofer 1982). Such a procedure has been applied already by Matzer & Mayrhofer (1993), Scheidegger (1993), and, in part, by Rambold *et al.* (1994).

2. Original definitions of single spore types have been modified or improved; the most important case in this context is the Dirinaria type. It was introduced by Mayrhofer (1982: 315) for ascospores lacking a torus and with internal wall thickenings of the Physcia, Mischoblastia, and/or intermediate types. In subsequent studies, the mode of spore ontogeny in this spore type (apical internal spore wall thickenings appear **before** the septum is inserted) was used more or less implicitly as the major character for the definition of the Dirinaria type (Giralt & Matzer 1994; Giralt *et al.* 1995; Rambold *et al.* 1994), or this peculiar ontogeny was stressed as being a very important character (Giralt 1994; Giralt & Mayrhofer 1994a, b, 1995). In the present study this concept of the Dirinaria type is adopted.

Within the species treated in detail in the present study, the following ascospore types were observed:

Beltraminia type (incl. Buellia type): spores without internal wall thickenings, *Buellia distrata*.

Physconia type (incl. Dubyana and Sicula type): spores with ± pronounced septal wall thickenings, apical thickenings less pronounced or lacking, spore lumina at their distal ends (i.e. near to the spore ends) rounded, *R. longisperma*.

Physcia type: septal and apical wall thickenings well developed, spore lumina at their distal ends concave, torus usually developed, in young spores the septum is inserted before wall thickenings become distinct, *R. confragosa*, *R. confragosula*, *R. scabridula*, *R. sp. 1*.

Milvina type: similar to the Physcia type, but particularly the apical wall thickenings are less pronounced, spore lumina at their distal ends flattened to slightly concave, *R. confragosula*, (*R. geesteranii*), *R. huillensis*, *R. scabridula*, *R. substellulata*, *R. subtristis*, *R. sp. 1*.

Mischoblastia type: septal and apical wall thickenings strongly pronounced, *R. oxydata s.l.*, *R. reagens*, *R. teichophiloides*.

Pachysporaria type: wall thickenings strongly developed around the lumina which are ± rounded, *R. confragosula*, (*R. geesteranii*), *R. huillensis*, *R. longisperma*, *R. microlepidea*, *R. reagens*, *R. scabridula*, *R. substellulata*, *R. subtristis*, *R. teichophiloides*.

Tunicata type: spores with a markedly thickened outer wall layer, *R. striatitunicata*.

Dirinaria type: when mature similar to the Physcia type (septal and apical wall thickenings well developed, spore lumina at their distal ends concave), but usually lacking a torus and with a different spore ontogeny: in young spores the septum is laid down after the formation of apical wall thickenings, *R. gennarii*, (compare also *R. geesteranii*).

As can be seen from this compilation, in most of the species the ascospores could not clearly be assigned to a single spore type. Most of the spores encountered belong to the Pachysporaria or Milvina type. In contrast to all other species treated in detail, the insertion of the septum in ascospores of *R. geesteranii* may occur before or after internal wall thickenings become distinct.

Spermogonial apparatus

The spermogonial apparatus in all species studied in this respect is typical of the genus *Rinodina*. Therefore,

we give here a general description which is not repeated in the species accounts:

Spermogonia immersed in the thallus, with the upper parts prominent or not, in longitudinal section ± globose, ellipsoid, cupuliform, or flask-shaped. Spermatiphores septate, composed of spermatogenous cells. Spermatogenous cells intercalar and terminal; intercalar cells ± cylindrical and with a lateral projection below the upper transverse septum; terminal cells ± flask-shaped or oblong-conical and with an apical projection; spermatia are formed on the lateral and apical projections. Spermatia bacilliform, hyaline, non-septate.

The spermatiphores correspond to type VI of Vobis (1980, as ‘Conidiophoren’). For illustrations of spermatiphores and spermatogenous cells respectively, see Matzer *et al.* (1994a) and Mayrhofer *et al.* (1993). The spermogonial apparatus of *R. longisperma* is basically of the same type as described above, but it differs in the way that intercalar spermatogenous cells could be observed only exceptionally.

BIOGEOGRAPHICAL NOTES

According to the present, rather incomplete data, saxicolous species of *Rinodina* from southern Africa show four different biogeographical elements or affinities. Particularly noteworthy is the high incidence of endemism.

1. Endemic element: this is the dominant element and includes ?*R. confragosula* (a record from New Caledonia seems to be dubious), *R. geesteranii*, *R. huillensis*, *R. longisperma*, *R. microlepidea*, *R. scabridula*, *R. striatitunicata*, *R. subtristis*, *R. teichophiloides*, and *R. sp. 1*. Most of these species have been found only in the Republic of South Africa and, in part, in adjacent countries, while *R. huillensis* and *R. subtristis* are known to extend further north to Angola.
2. African element: *R. substellulata* is known to occur in the Cape Province but also on some tropical islands adjacent to the African continent (Principe, Annobón, and Socotra).
3. New Zealand–South African element: an interesting distribution pattern is shown by *R. reagens* which has been found in New Zealand and in the Cape Province in South Africa.
4. Cosmopolitan element: this comprises *R. confragosa*, *R. gennarii*, and *R. oxydata s.l.*

Key to saxicolous *Rinodina* spp. in southern Africa

- 1a Medulla of thallus C+ red (containing gyrophoric acid); ascospores of Pachysporaria type, occasionally grading into Milvina type, small protrusions of lumina towards septum and/or spore ends may be present, (10–)12–18 (–24) × (6–)7–10(–12) µm 5. *R. huillensis*
- 1b Medulla of thallus C–:
- 2a Thallus K+ yellow; (atranorin usually detectable by tlc):
- 3a Ascospores of Physcia type, (15–)16–27 × 8–13 µm 1. *R. confragosa*
- 3b Ascospores not of Physcia type:
- 4a Ascospores of Pachysporaria type, occasionally grading into Milvina type, 14–20 × 7–12 µm ... 12. *R. substellulata*
- 4b Ascospores usually of Mischoblastia type, rarely with tendencies towards Pachysporaria type, 11–25 × (7–) 8–13 µm 8. *R. oxydata s.l.*

2b Thallus K-; (lacking atranorin):

- 5a Ascospores of Tunicata type, internal wall thickenings corresponding to Physcia type, mature spores with striate ornamentation, $(16-17-27 \times (10-11-17 \mu\text{m}))$ 11. *R. striatitunicata*
- 5b Ascospores not of Tunicata type, mature spores without striate ornamentation:
- 6a Hypothecium (always), epihymenium and spermogonia (not always) in longitudinal section distinctly K+ yellowish to orange; ascospores with internal wall thickenings of Mischoblastia type, occasionally grading into Pachysporaria type, torus absent, $22-31 \times 10-19 \mu\text{m}$; on calcareous rocks 9. *R. reagens*
- 6b Hypothecium, epihymenium, and spermogonia K-:
- 7a Thallus partially blastidiate, blastidia usually situated at margins of thallus areolae; ascospores of Milvina, Pachysporaria or Physcia type, or intermediate between these types, $(12-15-20(-24) \times (6-7-10(-13) \mu\text{m}))$ 10. *R. scabridula*
- 7b Thallus smooth or with an irregular surface but not blastidiate:
- 8a In young ascospores septum is inserted **after** formation of internal apical wall thickenings, spores lacking a torus in all stages of ontogeny:
- 9a Ascospores of Dirinaria type, in young spores septum is always inserted **after** formation of internal apical wall thickenings, spores $(11-12-17 \times (5-6-9 \mu\text{m}))$; hymenium 60-80 μm tall; thallus thin, occasionally inconspicuous, crustose, areolate or \pm effuse, smooth; apothecia often numerous and crowded 4. *R. gemarii*
- 9b Ascospores with internal wall thickenings which intervene between Pachysporaria and Milvina type, ontogeny of spores apparently irregular; in young spores the septum is inserted before or after internal wall thickenings become distinct, spores $14-21(-24) \times 8-13(-15) \mu\text{m}$; hymenium 100-115 μm tall; thallus thick, crustose to slightly squamulose, areolate, large areolae and squamules with an irregular surface 3. *R. geesteranii*
- 8b In young ascospores septum is inserted **before** formation of internal wall thickenings, torus in mature spores present or absent:
- 10a Ascospores without torus but intense brown pigmentation in septal region may simulate presence of a torus:
- 11a Ascospores at first with internal wall thickenings of Mischoblastia type, then corresponding to Pachysporaria type, $(16-20-32 \times 10-18 \mu\text{m})$, in young spores septum is inserted before internal wall thickenings become distinct, torus absent but intense brown pigmentation in septal region may simulate presence of a torus; apothecia to 0.8 mm diam. 14. *R. reichophiloidea*
- 11b Ascospores with internal wall thickenings which intervene between Pachysporaria and Milvina type, $14-21(-24) \times 8-13(-15) \mu\text{m}$, ontogeny of spores apparently irregular; in young spores septum is inserted before or after internal wall thickenings become distinct, spores always without intense brown pigmentation in septal region which may simulate presence of a torus; apothecia to 0.5 mm diam. 3. *R. geesteranii*
- 10b Ascospores usually with distinct torus (in some spores torus may be indistinct):
- 12a Ascospores of Physcia type, rarely grading into Milvina type, $11-17 \times 6-9 \mu\text{m}$ 15. *R. sp. 1*
- 12b Ascospores not of Physcia type or, when of Physcia type usually distinctly larger:
- 13a Apothecia small, to 0.3 mm diam., cryptolecanorine; ascospores small, similar to Pachysporaria type or \pm of Physconia type, occasionally with strongly pronounced apical internal wall thickenings, partly with protrusions of lumina to spore ends and/or septum, spores $10-16(-18) \times 6-10(-12) \mu\text{m}$; spermatia comparatively long, $(4-6-9 \times 1.0-1.5 \mu\text{m})$ 6. *R. longispermata*
- 13b Not with this combination of characters; spermatia up to 5 μm long:
- 14a Thallus whitish, yellowish, ochraceous; apothecia to 0.4 mm diam., lecanorine, rarely cryptolecanorine, disc light brown to dark brown or blackish; ascospores of Pachysporaria type, $(13-15-19(-20) \times 8-15 \mu\text{m})$ 7. *R. microlepidia*
- 14b Not with this combination of characters; apothecia becoming larger (to 0.8 mm diam.):
- 15a Thallus often greyish (also grey-brown, brown, occasionally whitish due to presence of a pruina); apothecia to 0.8 mm, usually cryptolecanorine (rarely lecanorine or lecidine), disc usually purely black (rarely dark brown); ascospores very variable in formation of internal wall thickenings; Pachysporaria, Milvina, or intermediate types, occasionally also of Physcia type or spore lumina irregularly biconical in shape, spores $14-32 \times 7.5-16.0 \mu\text{m}$ 2. *R. confragosula*
- 15b Thallus brown to ochraceous; apothecia to 0.7 mm diam., usually lecidine or lecanorine (occasionally cryptolecanorine), disc dark reddish brown to black; ascospores of Pachysporaria type, occasionally grading into Milvina type, $(15-16-23 \times 8-16 \mu\text{m})$ 13. *R. subtristis*

1. *Rinodina confragosa* (Ach.) Koerb. in Systema lichenum Germaniae: 125 (1855).

For synonyms and typification see Mayrhofer & Poelt (1979) and Mayrhofer (1984a).

Thallus thin to thick, crustose to squamulose, continuous and areolate or composed of discrete areolae which may be \pm wart-like, whitish, pale grey to ochraceous; prothallus absent or present and then it may be strongly developed, brown to black. *Chemistry*: thallus K+ yellow, P \pm yellowish; tlc: atranorin, chloratranorin (not always), zeorin (not always), in the material from southern Africa an unidentified compound (rf-classes 6/6/6) was found.

Apothecia to 1.5 mm diam., lecanorine, in addition to thalline margin a proper margin may be developed, usually sessile, rarely adnate, disc brown to black, plane to convex. *Epihymenium* 5-20 μm tall, brown. *Hymenium* 80-110 μm tall. *Hypothecium* to 200 μm deep, hyaline. *Paraphyses* 1-3 μm , apices 3-5 μm wide. *Asci* corresponding to Lecanora type, usually 8-spored. *Ascospores* (Figure 1B) of Physcia type, septum in young spores inserted before internal wall thickenings become distinct, torus developed, spores finely scabrid, without septal swellings in KOH, $(15-16-27 \times 8-13 \mu\text{m})$. *Spermogonia* (in material from southern Africa) immersed in thallus, ostiolar region blackish. *Spermatia* 4.0-5.5 \times 1.0-1.5 μm .

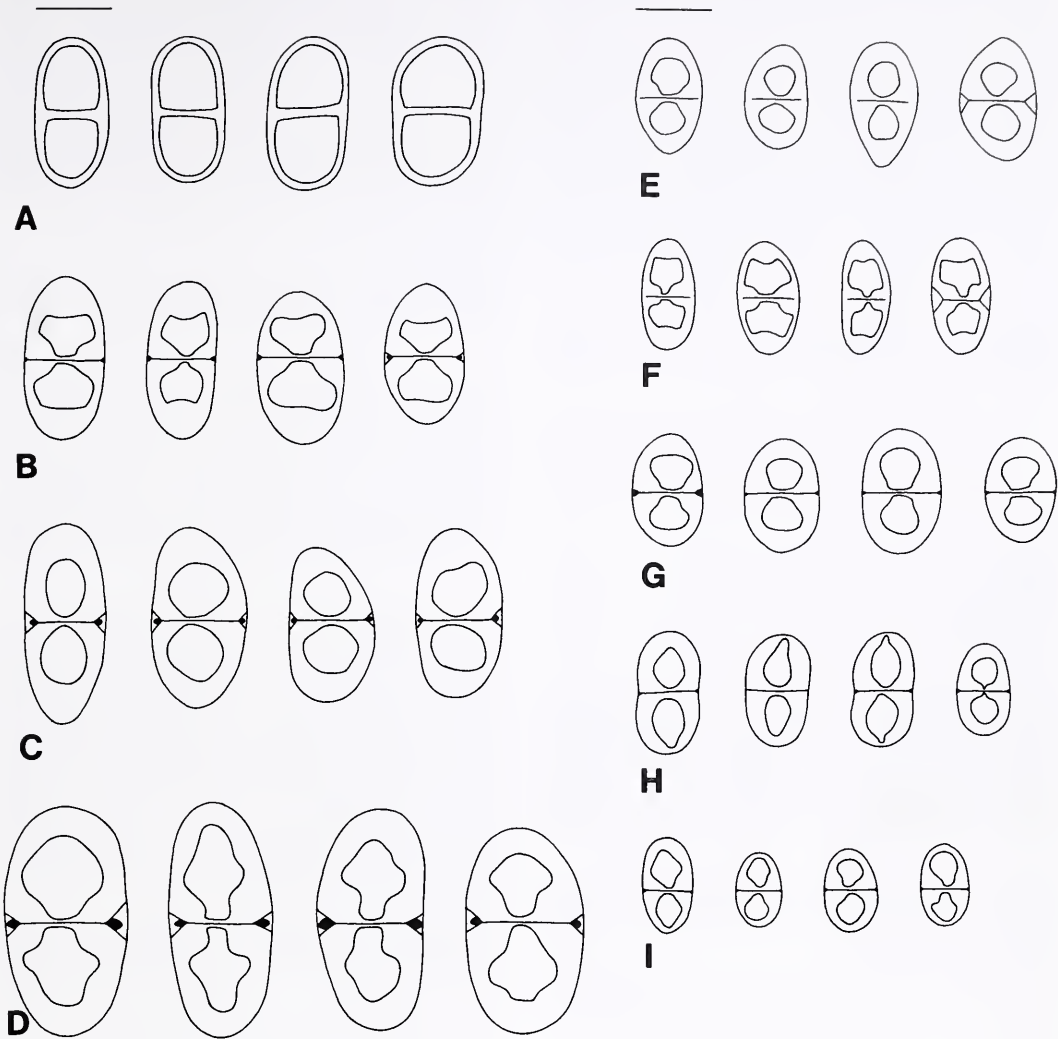


FIGURE 1.—Ascospores of southern African *Buellia* and *Rinodina* species. A, *Buellia distrata*, lectotype (BM); B, *Rinodina confragosa*, Zimbabwe, Lundi River, 27-6-1963, Kofler s.n. (LD); C, *R. confragosa*, isotype (BM); D, *R. confragosa* (PRE 2089b); E, *R. geesteranii*, holotype (L); F, *R. gennarii*, Almborn 1249 (GZU); G, *R. huillensis*, Brusse 4462 (PRE); H, *R. huillensis*, Rambold 7389 (M); I, *R. longisperma*, holotype (PRE). Scale bars: 10 μ m.

Rinodina confragosa is a widespread species in Europe including adjacent Asia (e.g. Fox & Purvis 1992; Giralt & Barbero 1995; Mayrhofer 1984a (distribution map); Mayrhofer & Poelt 1979; Nimis 1993; Santesson 1993), but it is hitherto only known from two localities in southern Africa (Zimbabwe and Western Cape; Figure 2). It is also reported from Australia (McCarthy 1991) and North America (e.g. Egan 1987). The record of *Lecanora confragosa* (= *Rinodina confragosa*) from São Tomé (Insula Caprarum, H-NYL 29006) by Nylander (1887, 1889) and Stizenberger (1890) actually refers to a taxon of the *Rinodina oxydata* group (see under *R. oxydata* in the present study, Table 1). In the area studied, *R. confragosa* grows on quartzitic rocks (including quartzitic sandstone); the specimen from Zimbabwe was associated with a *Pelulula*

sp. and cyanobacteria indicating that this habitat more or less regularly receives liquid water.

Among the species treated in the present study, *Rinodina confragosa* can be recognized easily by the K+ yellow thallus reaction and by the ascospores of Physcia type. As far as thallus formation is concerned, the species shows a wide range of variation in Europe, from thinly crustose to only slightly squamulose (these morphotypes are also present in southern Africa) to very thick and then with \pm wart-like to squamulose areolae; the thallus is continuous and rimose-cracked or composed of discrete areolae, and a prothallus may be absent or strongly developed. Variability can also be observed in chemistry, and different chemical races appear

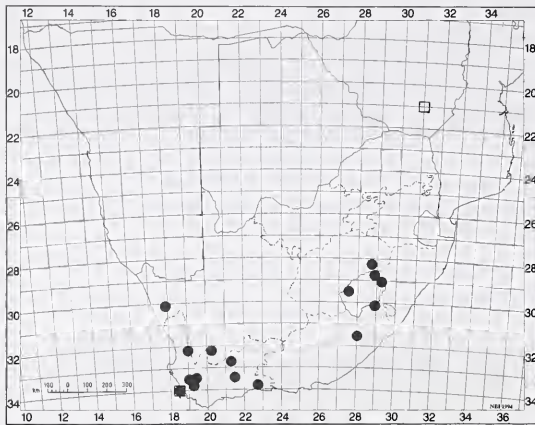


FIGURE 2.—Known distribution of *Rinodina confragosula* in southern Africa, □; and of *R. confragosula*, ●. Two collection localities of *R. confragosula* could not be located in detail and are therefore not mapped: Lesotho, Mamerthes; KwaZulu-Natal, Drakensberg, on ridge of the Sugar Loaf near The Cavern.

to exist (Hecklau *et al.* 1981; Mayrhofer & Leuckert 1985).

Vouchers from southern Africa: *Almborn* 1834 (LD); *Kofler s.n.* (LD).

2. *Rinodina confragosula* (Nyl. in Cromb.) Müll.Arg. in *Revue Mycologique* (Toulouse) 9: 79 (1887). Type: Western Cape, Table Mtn, Cape of Good Hope, 9-1874, A.E. Eaton *s.n.*, Venus Transit Expedition (BM, lecto., designated by Mayrhofer: 400 (1984a); BM, iso.); (H-NYL 28565, iso.), not seen, compare Mayrhofer (1984a: 400).

Lecanora confragosula Nyl. in Cromb.: 172 (1876b).

Rinodina almbornii H. Mayrhofer: 374 (1984a). Type: Western Cape, Dist. Paarl, Paarl Rock near summit, 2300 ft, 26-9-1953, O. Almborn 5540 (LD, holo.; GZU, iso.).

Thallus crustose, rimose-areolate, some areolae occasionally in the form of small squamules, greyish, grey-brown, brown, occasionally whitish due to presence of a pruina; in longitudinal section outermost layer of the phenocortex is brown or, particularly in areolae which bear an apothecium, (blackish to) blue-green; prothallus absent or present, black. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.8 mm diam., cryptolecanorine, more rarely lecanorine or becoming lecideine and then adnate, occasionally contiguous, disc black, rarely dark brown, occasionally whitish pruinose, the disc may be surrounded by a small edge of white pruina, disc slightly concave, plane, or convex. *Exciple*: where a proper exciple is developed it is brown and blackish to blue-green in parts or dominantly blue-green. *Epithymenium* 10–30(–35) μ m tall, entirely brown to olivaceous, brown to olivaceous and blue-green in parts, or dominantly blue-green with brown to olivaceous spots. *Hymenium* 70–120(–130) μ m tall. *Hypothecium* to 250 μ m deep, hyaline; adjoining parts of the thallus to the hypothecium may be blue-green. *Paraphyses* 1–5 μ m, apices 3–6 μ m wide. *Asci* corresponding to *Lecanora* type, with 8 or less spores. *Ascospores* (Figure 1C, D) with internal wall thickenings of *Pachysporaria* or

Milvina type, or intermediate between these two types, occasionally also of *Physcia* type or spore lumina irregularly biconical in shape, septum in young spores inserted before internal wall thickenings become distinct, torus developed, spores finely scabrid, without septal swellings in KOH, 14–32 \times 7.5–16.0 μ m. *Spermogonia* immersed in the thallus, with the upper parts prominent or not, often contiguous, ostiolar region black or brown; in longitudinal section at base and laterally hyaline, rarely pale brownish, above brown to olivaceous and/or blackish to blue-green. *Spermatia* (3–)4–5 \times 1.0–1.5 μ m.

Chemical reaction of the blue-green pigment in the thallus, apothecia, and spermogonia: N+ red.

Rinodina confragosula grows on hard siliceous rocks such as granite, sandstone, and quartzite. It is known with certainty only from the Republic of South Africa and Lesotho where it was found to be widely distributed at altitudes between 450 m and 3 080 m (Figure 2). The specimen cited from Concepcion in Argentina (Müller Argoviensis 1889) represents a *Rinodina* species for which an appropriate name is not available at present. A record from New Caledonia was given by Müller Argoviensis (1887).

R. confragosula is a quite variable species in several respects (see description). It can be recognized best by the usually black apothecia, the presence of a blue-green, N+ red pigment in the phenocortex, apothecia, and spermogonia, and by the absence of lichen substances detectable by tlc. Within a single specimen, the range of spore size is often significantly smaller than given in the description of the species above, but in other specimens the range was found to be 18–31 \times 10–16 μ m (*PRE* 2089b), 20.0–27.5 \times 9–11 μ m (*Brusse* 2547), and 22–32 \times 10.5–16.0 μ m (*Brusse* 4575).

Other saxicolous species occurring in the study area and showing close similarities with *R. confragosula* include *R. longisperma*, *R. microlepidia*, and *R. subtristis*. *Rinodina longisperma* is distinguished from *R. confragosula* by smaller apothecia and ascospores, and by longer spermatia. The separation of *R. confragosula* from *R. microlepidia* and *R. subtristis* respectively, is discussed in detail under both the latter species.

The differences used for the delimitation of *Rinodina almbornii* from *R. confragosula* by Mayrhofer (1984a) are considered to fall within the variability of *R. confragosula*. Mayrhofer (1984a) pointed out that *R. confragosula* is closely related to *R. kozukensis* (Vain.) Zahlbr. which was described from Japan by Vainio (1921, as *Melanaspicilia kozukensis*). The relationship of these two species will be discussed in a forthcoming paper.

Rinodina argentiniana Müll.Arg. (Argentina, Concepcion, 1882, Lorentz, G, holo.!) differs from *R. confragosula* by having ascospores lacking a torus and by a different type of spore ontogeny (internal apical wall thickenings appear before the spore septum is inserted). The record of *R. argentiniana* from Lesotho (summit of Masiti Mountain, 6300 ft, 1929-30, Hewitt, TRH) by Mayrhofer (1984a) actually refers to *R. confragosula*. According to the material available, *R. argentiniana* does not occur in the study area.

One of the specimens cited by Mayrhofer (1984a) under *Rinodina depressa* could not be determined with certainty, and it is treated here under *R. cf. confragosula*: Western Cape, Van Rhynspass, Van Rhynsdorp, *Van der Byl* 766 (W).

Vouchers: *Almborn* 4567 (GZU, LD), 4847 (LD), 5540 (PRE), *s.n.* (GZU); *Brusse* 2547, 2633, 3136, 3282, 3397, 4575, 4625, 5557 (PRE); *O'Connor* CH 2220 (PRE); *Hean* (PRE 2089b); *Hewitt* *s.n.* (TRH); *Van der Plank*, CH 4568 (PRE); *Schelpel* 1110 (GZU); *Triebel & Rambold* 7896 (GZU), 7901 (M).

3. *Rinodina geesteranii* H.Mayrhofer in Journal of the Hattori Botanical Laboratory 55: 412 (1984a). Type: Western Cape, Wynberg Flats, SE of Cape Town, on granite outcrop near dusty road, 19-12-1949, *R.A. Maas Geesteranus* 14669 (L, holo.; GZU, iso.).

Thallus thick, crustose to slightly squamulose, areolate, brown, covered by a white pruina in parts, large areolae and squamules with an irregular surface; thallus occasionally associated with cyanobacteria; prothallus dark brown, blackish, well developed, at margin of thallus distinctly effigurate. *Chemistry*: no lichen substances detectable by tlc (Mayrhofer & Leuckert 1985).

Apothecia to 0.5 mm diam., cryptolecanorine or lecanorine and then adnate, rarely with a lecideine appearance, disc blackish, plane. *Epithymenium* 10–20 μ m tall, brown. *Hymenium* 100–115 μ m tall. *Hypothecium* to 120 μ m deep, usually hyaline. *Paraphyses* 1–4 μ m, apices 4–5(–6) μ m wide. *Asci* corresponding to Lecanora type, axial body often difficult to observe, asci often with 8 but also with less spores. *Ascospores* (Figure 1E) with internal wall thickenings intermediate between Pachysporaria and Milvina type, ontogeny of spores apparently irregular: septum in young spores inserted before or after internal wall thickenings become distinct, torus absent, spores finely scabrid, without septal swellings in KOH, 14–21(–24) \times 8–13(–15) μ m. *Spermogonia* immersed in the thallus, ostiolar region blackish. *Spermatia* \pm 3–4 \times 1–2 μ m.

Rinodina geesteranii is only known from the type locality on the Cape Peninsula where it was collected on hard quartzitic rocks (Figure 3). It is associated with other lichen species, most commonly with *Peltula euploca* (Ach.) Poelt in Pišút, suggesting that the locality is more or less regularly wetted by rain or dripping water (compare notes on the ecology of *Peltula euploca* in Büdel 1987: 58). This view is also supported by the fact that the thallus of *R. geesteranii* is partly associated with cyanobacteria; green algae containing lichens which have connections with free-living cyanobacteria occur exclusively at localities which receive liquid water (Poelt & Mayrhofer 1988).

R. geesteranii is characterized mainly by the thickly crustose to slightly squamulose thallus, and by the ascospores lacking a torus and with internal wall thickenings intermediate between Pachysporaria and Milvina type. Three other saxicolous *Rinodina* species with ascospores lacking a typical torus are known to occur in the study area, viz. *R. gennarii*, *R. reagens*, and *R. teichophiloides*. In *R. teichophiloides*, torus-like structures may be developed (see account of *R. teichophiloides* in the present study). *Rinodina gennarii* is separated from *R. geesteranii* mainly by a thin

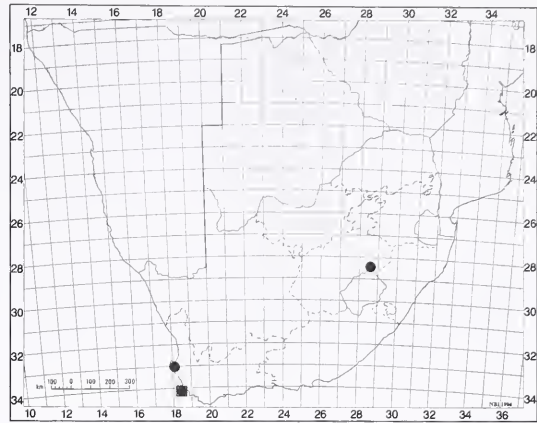


FIGURE 3.—Known distribution of *Rinodina geesteranii*, □; and of *R. gennarii* in southern Africa, ●.

thallus and ascospores with internal wall thickenings of Physcia type, and *R. reagens* and *R. teichophiloides* differ from *R. geesteranii* by the usually larger ascospores with internal wall thickenings of Mischoblastia or Pachysporaria type. In ascospore type and size close similarities can be observed between *R. geesteranii* and *R. argentiniana* Müll.Arg. (G, holo.). The latter was described from Argentina by Müller Argoviensis (1889). Both the species are only known from their type collections (for *R. argentiniana* see the discussion of *R. confragosula* in the present work). *R. argentiniana* is distinguished by the thinner, exclusively crustose thallus and larger apothecia (to 0.75 mm in diameter).

4. *Rinodina gennarii* Bagl. in Commentario della Società Crittogamologica Italiana 1: 17 (1861). Type: Italy, Liguria occidentale, alle falde del monte Faiallo dell' Appennino sopra Voltri, *Baglietto* *s.n.* (WU, iso.), not seen.

Synonyms: see Sheard (1967, under *Rinodina subexigua*), Mayrhofer & Poelt (1979), Mayrhofer (1984a).

The following description is based only on the specimens cited below.

Thallus thin, occasionally inconspicuous, crustose, areolate or \pm effuse, smooth, whitish, grey, ochraceous; prothallus absent. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.5 mm diam., often numerous, crowded, lecanorine or rarely lecideine, adnate to sessile, disc dark brown, a narrow brown border-line between disc and thalline margin may be present, disc plane to strongly convex. *Epithymenium* 10–15 μ m tall, brown. *Hymenium* 60–80 μ m tall. *Hypothecium* to 150 μ m deep, hyaline. *Paraphyses* 1–4(–5) μ m, apices 3–6 μ m wide. *Asci* corresponding to Lecanora type, 8-spored. *Ascospores* (Figure 1F) of Dirinaria type, septum in young spores inserted after the formation of internal apical wall thickenings, torus absent, spores smooth or finely scabrid, with or without septal swellings in KOH, 11(–)12–17 \times (5–)6–9 μ m. *Spermogonia* not observed.

Rinodina gennarii is widespread in temperate regions of the northern and southern hemisphere and is found on

a wide variety of substrata (e.g. Fox & Purvis 1992; Mayrhofer 1983, 1984a; Mayrhofer & Poelt 1979; Nimis 1993; Santesson 1993). The species is here recorded for South Africa where it occurs on granitic and quartzitic rocks from low to high altitudes (Figure 3).

This species is characterized mainly by ascospores of *Dirinaria* type and the numerous, often crowded, small apothecia. Giral & Mayrhofer (1995) did not observe marked differences between *R. gennarii* and the corticolous/lignicolous *R. oleae* Bagl. However, we refrain here from putting *R. gennarii* into the synonymy of *R. oleae*. *R. gennarii* and *R. oleae* are tentatively treated as a pair of closely related, similar species of which one is saxicolous and the other corticolous/lignicolous. Further observations, including detailed data on distribution and ecology are necessary to decide whether this concept can be maintained or not.

Rinodina gennarii and *R. oleae* are not the only example for vicarious species within the genus. Another corresponding pair of species is formed by the saxicolous *R. beccariana* Bagl. and the corticolous *R. roboris* (Duf. ex Nyl.) Arnold var. *roboris* (Mayrhofer *et al.* 1993). Furthermore, within *R. oxydata* s.l., almost all representatives are saxicolous with the exception of *R. euskadiensis* A. Crespo & M.B. Aguirre which is based on corticolous material (Crespo & Aguirre 1984; Giral & Matzer 1994).

Vouchers from southern Africa: *Almborn* 1227, 1250, 5020 (LD), 1249 (GZU, LD); *Triebel & Rambold* 6714 (M, under *Buellia* sp.), 6732 (M, under *Rinodina* sp.), 8399 (M).

5. *Rinodina huillensis* Vain. in Catalogue of African Plants collected by F. Welwitsch 2,2: 413 (1901). Type: Angola, Huilla [= Huila] (3800 ad 5500 ped.s.m.), ad rupes juxta cataractam Ferrão prope Lopollo, 1860, *Welwitsch* 50 (*TUR-V* 8736, holo.).

Buellia depressa Vain.: 415 (1901). *Rinodina depressa* (Vain.) Zahlbr.: 510 (1931). Type: Angola, Pungo Andongo, Pedra de Cazella, ad rupes et lapides gneissaceas, 1857, *Welwitsch* 64 (*TUR-V* 9112, lecto.), designated by Mayrhofer (1984a: 403); Pungo Andongo, ad rupes et lapides dispersas mont. Praesidii, Febr. 1857, *Welwitsch* 61 pr. p. (BM, para.); Pungo Andongo, ad rupes et lapides dispersas, Febr. 1857, *Welwitsch* 64 pr. p. (BM, para.); Pungo Andongo, Pedra de Cazella, ... [text illegible] ..., 1857, *Welwitsch* 481 pr. p. (BM, para.).

Rinodina albicans H. Mayrhofer: 373 (1984a). Type: Western Cape, Dist. George, 7 miles E of G., on rocks in a ravine, 14-8-1953, *O. Almborn* 2387 (LD, holo.).

Thallus usually thin, crustose, rimose-areolate, more rarely effuse, brown, grey-brown, grey, rarely whitish, pale ochraceous; phenocortex of apothecia-bearing areolae is brown, olivaceous, blackish, olivaceous to blackish pigment reacts N+ red; prothallus absent or present, black. **Chemistry:** medulla C+ red; tlc: gyrophoric acid (often together with lecanoric and orsellinic acid), 5-O-methylhiassic acid was detected in a single specimen.

Apothecia to 0.8 mm diam., cryptolecanorine, or lecanorine or more rarely lecideine and then adnate, occasionally a proper margin is developed, disc dark reddish brown, dark brown, black, plane to convex. **Proper exciple** in its outer parts brown or olivaceous to blackish and then N+ red. **Epithymenium** 10–20 μ m tall, reddish brown, brown, occasionally dirty olivaceous and then N+ red in

part. **Hymenium** 70–120 μ m tall. **Hypothecium** to 150 μ m deep, hyaline. **Paraphyses** 1–4 μ m, apices 3–5(–6) μ m wide. **Asci** corresponding to *Lecanora* type, axial body easy to observe or indistinct, sometimes surrounded by a tube-like structure, asci usually with 8 but also with less than 8 spores. **Ascospores** (Figure 1G, H) of *Pachysporaria* type, occasionally grading into *Milvina* type, small protrusions of lumina towards septum and/or spore ends sometimes present, septum in young spores inserted before internal wall thickenings become distinct, torus developed, spores smooth to finely scabrid, without septal swellings in KOH, (10–)12–18(–24) \times (6–)7–10(–12) μ m. **Spermogonia** immersed in thallus, partly somewhat raised, ostiolar region (dark) red-brown to blackish. **Spermatia** 3–6(–7) \times 1.0–1.5 μ m.

Rinodina huillensis is a widespread species in southern Africa and is so far known from Angola, the Republic of South Africa, and Swaziland. It occurs on granite, quartzitic rocks and sandstone at a range of altitudes (Figure 4).

Among the saxicolous *Rinodina* species known to occur in the study area, *R. huillensis* alone contains gyrophoric acid in the thallus (medulla C+ red), often accompanied by lecanoric and orsellinic acid. It is a well-known phenomenon in many lichens that in addition to gyrophoric acid, at least traces of lecanoric and orsellinic acid can be found (e.g. Schreiner & Hafellner 1992: 22). Further saxicolous species of *Rinodina* containing gyrophoric acid occur outside southern Africa, but these are distinguished from *R. huillensis* by several characters (Matzer *et al.* 1994a). In a single specimen of *R. huillensis*



FIGURE 4.—Known distribution of *Rinodina huillensis*.

(Brusse 4497, PRE) 5-O-methylhiascic acid was detected. This lichen compound was also reported from *Rinodina tephraspis* (Tuck.) Herre, a northern hemisphere species which differs chemically from *R. huillensis* by the presence of zeorin (Mayrhofer *et al.* 1992).

Re-examination of the types of *Rinodina albicans* and *R. depressa* revealed that these names are synonyms of *R. huillensis*. Vainio (1901) described *R. huillensis* and *R. depressa* (as *Buellia depressa*) in the same publication; *R. huillensis* is selected here as the correct name as it was mentioned first in Vainio's paper and appropriate generic classification was applied. The statement of Mayrhofer & Leuckert (1985) that *R. depressa* does not contain lichen substances is based on the following specimen: Republic of South Africa, Roggeveld Mountains, Brusse 3265 (PRE). We studied this specimen, and it may represent a *Rinodina* species but cannot be identified with certainty as the ascospores are badly developed. From its external morphology it can be concluded that it is not *R. huillensis*. One of the specimens (Van der Byl 766, W) cited under *R. depressa* by Mayrhofer (1984a) is treated as *Rinodina* cf. *confragosula* in the present paper. Several specimens mentioned by Mayrhofer (1984a) under *R. huillensis* do not belong to this species: one from Angola (Humpata Plateau, 6-2-1960, Degelius, GZU) refers to *R. subtristis* whereas the other one from the same country was not examined. The material from Namibia (Haifischbucht, Fincke, W) represents *Rinodina longisperma*, a species newly described in the present study. The specimen from the Northern Province (Transvaal, Louis Trichardt, 8-10-1953, Almborn, LD) was selected as the isotype of *Rinodina scabridula* in the present work. Another specimen from Mpumalanga (Eastern Transvaal) was also cited: Dist. Pilgrims Rest, 4 miles SE of P. R., on rocks near the road, 22-10-1953, Almborn (LD). We examined two specimens held in LD which are labelled as indicated above but with different collection numbers: Almborn 7831 actually represents *R. huillensis* whereas the crustose lichen species in Almborn 7836 has hyaline ascospores and does not belong to the Physciaceae. The collection of *R. huillensis* from (Orange) Free State (Ladybrand, Maas Geesteranus 6534, L, LD) was cited under *Rinodina microleptidea* by Mayrhofer (1984a).

Vouchers: Almborn 4579 (LD, under *Arthonia* sp.), 7831, 7865, 8615 (LD), 6168 (PRE); Brusse 1688, 3703 (GZU), 1634 (PRE, under *Rinodina substellulata*), 1688, 1764, 2773, 2947, 3581, 3655, 4453, 4462, CH 4628 (PRE), 4497 (GZU, PRE); Van der Byl 756 (W); J. Hafellner & A. Hafellner, 30651 (Hafellner); Maas Geesteranus 6534 (L, LD); Triebel & Rambold 7353 (GZU, M), 7389 (M).

6. *Rinodina longisperma* Matzer & H. Mayrhofer sp. nov.

Thallus saxicola, crustaceus, rimosi-areolatus, griseus ad brunneus, interdum pruinosis. Apothecia ad 0.3 mm in diametro, cryptolecanorina; disci fusi ad atri, plani. Epithymenia 5–15 μ m alta, brunnea. Hymenia 50–90 μ m alta. Hypothecia ad 100 μ m alta, hyalina. Paraphyses 1–3(–4) μ m crassae, apicibus (2–)4–5(–6) μ m crassis. Asci tholis similibus typo generis '*Lecanora*' instructi. Ascosporae 10–16(–18) \times 6–10(–12) μ m magnae, typo Pachysporaria vel Physconia similes, toro evoluti. *Spermogonia*

in thallo immersa. *Spermatia* bacilliformia, (4–)6–9 \times 1.0–1.5 μ m magna.

TYPE.—Namibia, 2216 (Otjimbingwe): 10–20 km S of Windhoek, Auasberge, Regenstein Farm, gorge behind fort, (—DC), on quartzite, 26-3-1984, F. Brusse 4264 (PRE, holo., with *Cercidospora* sp. and *Dactylospora* sp.; GZU, iso.).

Thallus crustose, rimose-areolate, grey, grey-brown, brown, occasionally whitish pruinose; prothallus occasionally developed, dark brown, black. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.3 mm diam., cryptolecanorine, disc dark reddish brown, dark brown to blackish, partly with a small border line of white pruina, plane. *Epithymenium* 5–15 μ m tall, brown. *Hymenium* 50–90 μ m tall. *Hypothecium* to 100 μ m deep, hyaline. *Paraphyses* 1–3(–4) μ m, apices (2–)4–5(–6) μ m wide. *Asci* corresponding to *Lecanora* type, axial body often indistinct or not observable, asci usually 8-spored. *Ascospores* (Figures 11; 5A) similar to *Pachysporaria* type or \pm of *Physconia* type, occasionally with strongly pronounced apical internal wall thickenings, partly with protrusions of lumina to spore ends and/or septum, septum in young spores inserted before internal wall thickenings become distinct, torus small but well distinct, spores smooth, without septal swellings in KOH, 10–16(–18) \times 6–10(–12) μ m. *Spermogonia* immersed in thallus, ostiolar region grey, brown, blackish. *Spermatophores* septate; spermatogenous cells usually terminal, rarely intercalary; terminal spermatogenous cells flask-shaped, forming spermatia apically; intercalary spermatogenous cells with a lateral projection below upper transverse septum with spermatia formed on lateral projections. *Spermatia* (4–)6–9 \times 1.0–1.5 μ m.

Rinodina longisperma is so far known from quartzitic rocks including sandstone from Namibia and the Republic of South Africa (Figure 6).

Rinodina longisperma can be recognized best by a set of characters including the small and cryptolecanorine apothecia, the small ascospores similar to *Pachysporaria* or *Physconia* type, and, particularly, by the relatively long spermatia (hence the epithet '*longisperma*'). The bulk of *Rinodina* species in which spermatia have been observed possess spermatia with length measurements from 3 to 6 (to 7) μ m, whereas in *R. longisperma* they are (4–)6–9 μ m long. In addition, peculiarities could also be observed in the spermatogenous apparatus of *R. longisperma*. Most of the *Rinodina* species studied in this respect have many terminal and intercalary spermatogenous cells (e.g. see 'morphology and anatomy' in the general part of the present study; Matzer *et al.* 1994a: 108, fig. 8). In *R. longisperma* most of the spermatogenous cells are terminally arranged, whereas those with an intercalary position could be observed only exceptionally.

One of the specimens of *R. longisperma* from Namibia (Haifischbucht, Fincke, W) was included in *R. huillensis* by Mayrhofer (1984a).

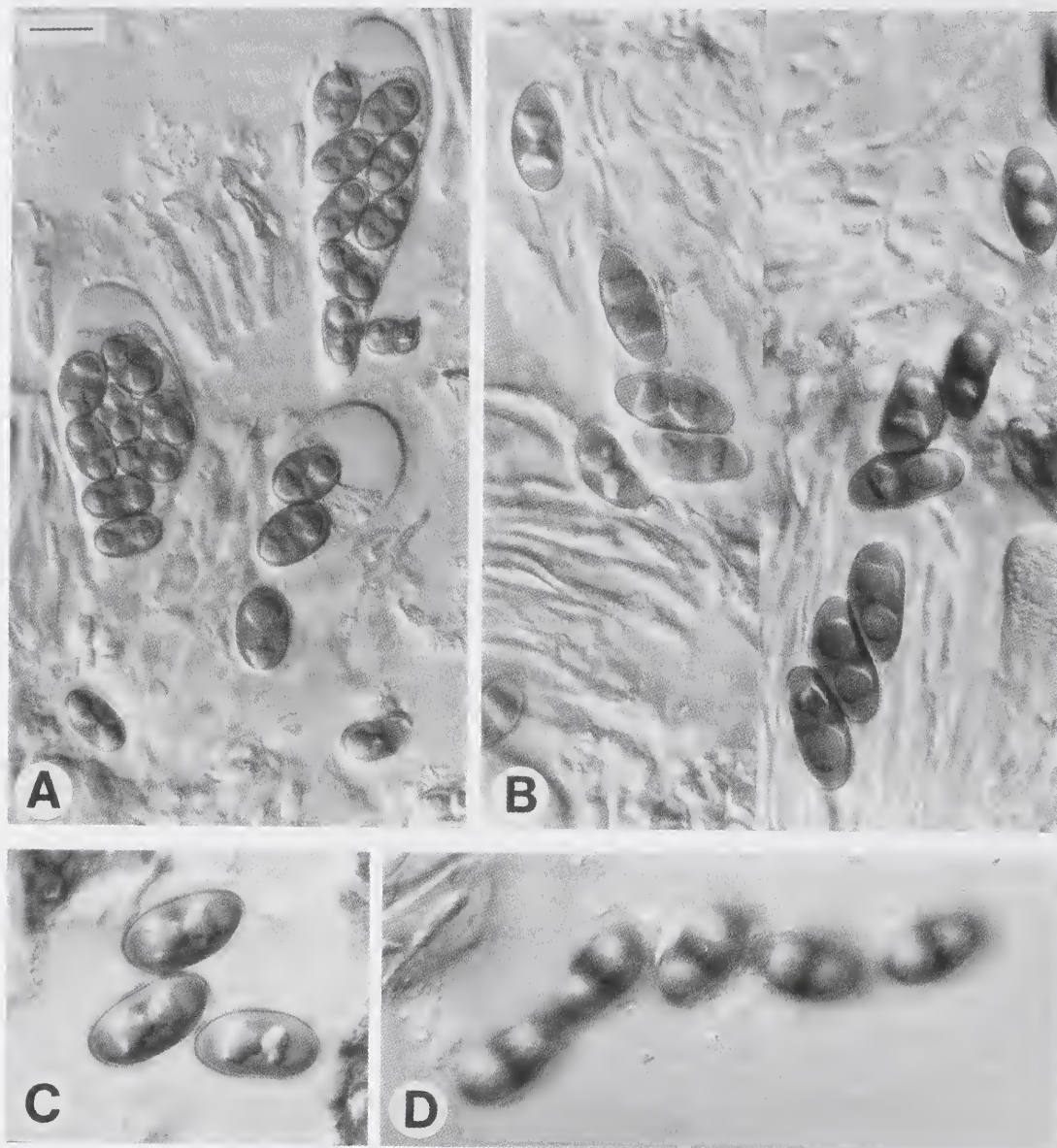


FIGURE 5.—Ascospores of southern African *Rinodina* species. A, *R. longisperma*, holotype (PRE); B, *R. scabridula*, holotype (GZU); C, D, *R. striatitunicata*, holotype (GZU); D, ascospores in surface view showing their striate ornamentation. Scale bar: 10 μ m.

Specimens examined:

NAMIBIA.—2016 (Otjiwarongo): 7 km S of Otjiwarongo, (–DA), 21-3-1984, *Brusse* 4210 (PRE). 2017 (Waterberg): Waterberg plateau, (–AD), 23-3-1984, *Brusse* 4246 (PRE). Haifischbucht, grid. ref. unknown, *Fincke* s.n. (W).

NORTHERN CAPE.—3123 (Victoria West): Dist. Victoria West, Three Sisters, (–CC), 2-10-1953, *Almborn* 5779 (LD).

7. *Rinodina microlepiledea* Müll.Arg. in *Flora* 71: 206 (1888). Type: Mpumalanga, Eastern Transvaal, Lydenburg, *Wilms* 76 (G, holo!).

Lecanora microlepiledea (Müll.Arg.) Stizenb.: 209 (1890).

Thallus thin, crustose, rimose-areolate, continuous or composed of discrete areolae, whitish, yellowish, ochraceous; prothallus not distinct. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.4 mm diam., lecanorine, rarely cryptolecanorine, disc light brown to dark brown or blackish, \pm plane. *Epithymenium* 5–20 μ m tall, brown. *Hymenium* \pm 90–100 μ m tall. *Hypothecium* to 180 μ m deep, hyaline. *Paraphyses* 1–3 μ m, apices 3–4 μ m wide. *Asci* corresponding to *Lecanora* type, usually 8-spored. *Ascospores* (Figure 7A) of *Pachysporaria* type, septum in young spores probably inserted before internal wall thickenings

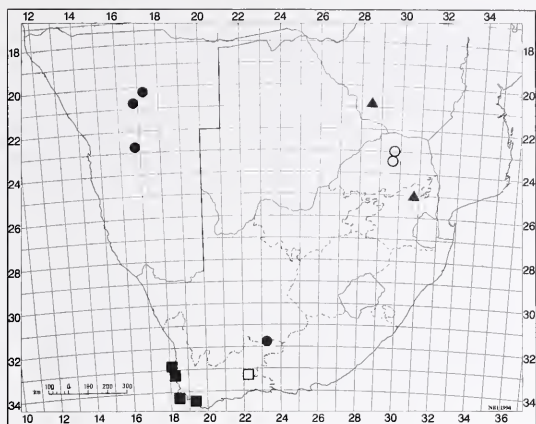


FIGURE 6.—Known distribution in southern Africa: *Rinodina longisperma*, ●, [locality of Fincke s.n. (W) could not be located exactly and is therefore not mapped: SWA/Namibia, Haifischbucht]; *R. microleptidea*, ▲; *R. reagens*, ■; *R. scabridula*, □; and *R. striatitunicata*, ○.

become distinct, torus small (not always distinct), spores smooth to finely scabrid, $(13\text{--}15\text{--}19\text{--}20) \times 8\text{--}15\text{ }\mu\text{m}$. *Spermogonia* immersed in thallus, ostiolar region pale, brown. *Spermatia* $4\text{--}5 \times 1.0\text{--}1.5\text{ }\mu\text{m}$.

In its present circumscription, the species is known only from single localities in the Republic of South Africa and Zimbabwe where it grows on hard siliceous rocks (Figure 6).

The status of *Rinodina microleptidea* is rather vague. The description given above is based only on two rather scant specimens and thus, not all characters (e.g. ascus type, behaviour of ascospores in potassium hydroxide) could be studied in full detail. Unfortunately, the type collection is in a very poor condition, and the apothecia in particular are very old or damaged. Therefore, no statements can be given on the variability of *R. microleptidea* and only one further specimen which looks more or less similar to the type is accepted as belonging to that taxon. The distinction between *Rinodina subtristis* and *R. microleptidea* is problematical. According to the material available, the former species is separated by larger apothecia (to 0.7 mm diam.) and the coloration of the thallus: brown or ochraceous instead of whitish, yellowish to ochraceous. Like *R. microleptidea* and *R. subtristis*, other *Rinodina* species in the study area are characterized by the lack of secondary lichen substances and ascospores of Pachysporaria or similar types. This includes *R. confragosula*, *R. longisperma*, and *R. scabridula*. *Rinodina confragosula* differs from *R. microleptidea* mainly by its larger apothecia (to 0.8 mm diam.) and by ascospores which are rather variable in the formation of internal wall thickenings (Pachysporaria, Milvina, Physcia, or intermediate types or the spore lumina are irregularly biconical) and exhibit a broader size range ($14\text{--}32 \times 7.5\text{--}16.0\text{ }\mu\text{m}$). *Rinodina longisperma* is separated from *R. microleptidea* mainly by its often smaller ascospores, $10\text{--}16\text{--}(18) \times 6\text{--}10\text{--}(12)\text{ }\mu\text{m}$, and longer spermatia, $5\text{--}9\text{ }\mu\text{m}$. *Rinodina scabridula* can easily be distinguished by the formation of blastidia on the thallus.

The following specimens were included in *R. microleptidea* by Mayrhofer (1984a), but for a range of reasons a new settlement is proposed here: (Orange) Free State, Ladybrand, *Maas Geesteranus* 6534 (L, LD) belongs to *Rinodina huillensis*. The specimen from (Orange) Free State, Dist. Trompsburg, 2-10-1953, *Almborn* 5809 (LD) which is cited by Mayrhofer (1984a) with the date '2-10-1954', collection number '5808', and herbarium 'L' represents a *Rinodina* sp. The ascospores are usually 2-celled but exceptionally also 3-celled spores could be observed. The *Rinodina* species from the Western Cape, Calitzdorp-Kruisrivier, *Maas Geesteranus* 6711 (L) differs from *R. microleptidea* by the type of spore ontogeny in the way that internal wall thickenings appear before the septum is inserted. The ascospores of this specimen resemble those of *R. geesteranii*, but differences exist in the morphology of the thallus.

Voucher: Kofler s.n. (LD).

8. *Rinodina oxydata* s.l.

Rinodina oxydata s.l. is distributed world-wide. The following description is based on material from southern Africa only. For further explanations see the discussion given below.

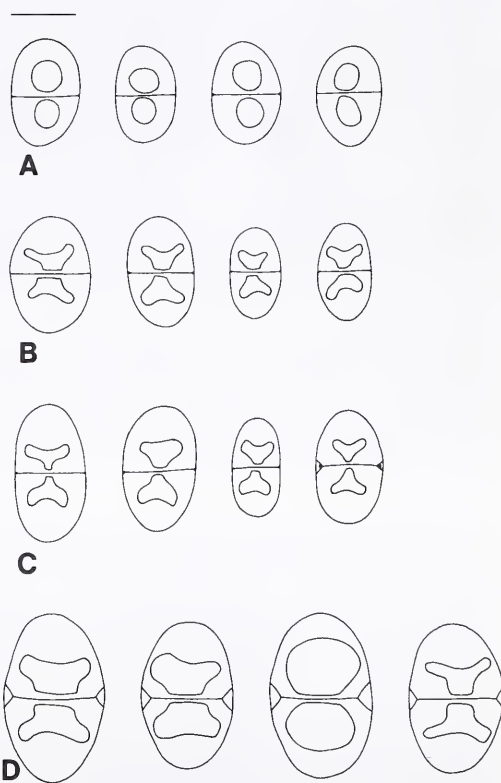


FIGURE 7.—Ascospores of southern African *Rinodina* species. A, *R. microleptidea*, holotype (G); B, *R. oxydata* s.l., [holotype of *R. minima*] (LD); C, *R. oxydata* s.l., *Almborn* 7104 (LD); D, *R. reagens*, *Hafellner* 30655 (herb. Hafellner). Scale bar: $10\text{ }\mu\text{m}$.

Thallus thin, crustose, areolate, continuous, yellowish, pale ochraceous, pale greyish; prothallus absent or present, blackish. *Chemistry*: thallus K+ yellow; tlc: atranorin (not found in *Rinodina minima*; see below).

Apothecia to 0.4 mm diam., cryptolecanorine, lecanorine, or with a lecideine appearance (algal cells may be enclosed in the exciple), when lecanorine or lecideine then adnate, disc dark reddish brown to blackish, proper margin black, disc usually plane. *Proper exciple* in its outer layer with an olivaceous, blue-green to blackish pigment which reacts N+ red, in addition a brown pigment (N-) may be present. *Epilhymenium* 10–20 µm tall, brown. *Hymenium* 70–100 µm tall. *Hypothecium* to ± 80 µm deep, hyaline. *Paraphyses* 1–4 µm, apices 3–6 µm wide. *Asci* corresponding to Lecanora type, with tendencies towards Bacidia type, axial body may be indistinct, asci often with 8 but also with less spores. *Ascospores* (Figure 7B, C) usually of Mischoblastia type, rarely with tendencies towards Pachysporaria type, septum in young spores inserted before internal wall thickenings become distinct, torus delicate, spores smooth or finely scabrid, with or without slight septal swellings in KOH, 11–25 × (7–)8–13 µm. *Spermogonia* immersed in thallus, occasionally slightly raised, ostiolar region dark reddish brown to blackish. *Spermatia* (3–)4–5 × 1.0–1.5 µm.

In the study area, *Rinodina oxydata* s.l. is known only from three localities (Mozambique, Transvaal, Table Mountain) where it grows on schistic and quartzitic rocks.

The name *Rinodina oxydata* is commonly applied to lichens exhibiting the following set of characters: thallus thinly crustose or thick and nearly squamulose, occasionally evanescent, containing atranorin (K+ yellow), apothecia showing a wide variety from cryptolecanorine, lecanorine to lecideine, ascospores (usually) of Mischoblastia type. Particularly, in thallus formation, in the apothecial type, and, in part, in ascospore size, a wide range of variability can be observed. Many binomials have been introduced for lichens with characters mentioned above, but none of these names can be used unequivocally unless a thorough revision of the *R. oxydata* group on a world-wide scale has been carried out (see Table 2). Such a revision should also include *R. substellulata*, a species with ascospores of Pachysporaria type occasionally grading into Milvina type, but in all other characters displaying close similarities with *R. oxydata*. All characters used for

the delimitation of species (thallus formation, apothecial type, ascospore size) are not constant and show various transitional states, especially when many specimens are analyzed. On the other hand, it seems to be premature to put all these names into synonymy of *R. oxydata* (A.Massal.) A.Massal. As a consequence, the description given above includes all *R. oxydata*-like lichens known from southern Africa, and a survey on the 'species' known from that region is given in Table 1 below.

Rambold *et al.* (1994) argued for a possible re-establishment of the generic name *Mischoblastia* A.Massal. which may be based on *Rinodina oxydata*. The most important characters mentioned to be characteristic for *Mischoblastia* are: asci corresponding to Bacidia type, ascospores of Mischoblastia type, presence of an aeruginose, N+ red pigment in the exciple. However, it should be stressed here that all these characters do not justify a separation of *Mischoblastia* from *Rinodina* (Ach.) Gray; this is evident from the following observations: 1, asci of *R. oxydata* (and of species which are considered to be closely related to *R. oxydata*) exhibit a considerable range of variation and correspond either to Bacidia type or to Lecanora type, or are more or less intermediate between these two types; 2, the presence of Mischoblastia type ascospores cannot be an argument as the formation of pronounced internal wall thickenings is one of the most important characters of the genus *Rinodina*; 3, an aeruginose, N+ red pigment occurring in the exciple and/or in the epilhymenium is known not only from *R. oxydata* and related species but also from other *Rinodina* species: e.g. *R. beccariana* Bagl. (Mayrhofer *et al.* 1993), *R. canariensis* Matzer, H.Mayrhofer & P.Clerc (Matzer *et al.* 1994a), *R. cotfragosula* (Nyl. in Cromb.) Müll.Arg. (see present study), and *R. trachytica* (A.Massal.) Bagl. & Car. (Mayrhofer *et al.* 1992).

Specimens examined

MOZAMBIQUE:—Sul do Save, Dist. Maputo (Lourenço Marques), 8 km E of Impamputo, on rocks near road, 18-10-1953, *Almborn* 7102, holotype of *Rinodina minima* (LD); same locality, 18-10-1953, *Almborn* 7104 (LD).

NORTHERN TRANSVAAL.—On granite from the Lebombo in Transvaal, *Wilms* s.n., holotype of *Rinodina detecta* (ZT).

WESTERN CAPE.—Cape of Good Hope, Table Mtn, September 1874, *Eaton* s.n., Venus Transit Expedition (BM, associated with the lectotype of *Rinodina subtristis*).

TABLE 1.—*Rinodina oxydata*-like lichens known to occur in southern Africa; for further explanations see the discussion in the text

| Species | Ascospore type and size | Known distribution | Important literature |
|--|---|--|---|
| <i>R. detecta</i> (Stizenb.) Zahlbr. (1931) | Intermediate between the Mischoblastia and Pachysporaria type, ± 19–25 × 10–15 µm | South Africa: Transvaal (only known from the scant holotype) | Mayrhofer (1984a) |
| <i>R. minima</i> H.Mayrhofer (1984a) | Mischoblastia type, 11–20(–23) × (7–)8–13 µm | Mozambique (with certainty only known from the holotype*) | Mayrhofer (1984a) |
| ? <i>R. oxydata</i> (A.Massal.) A.Massal. (1854) | Mischoblastia type, ± 17–25 × 9–14 µm | in the present circumscription world-wide | Mayrhofer & Poelt (1979); Sheard (1967) |

* A second specimen was cited by Mayrhofer (1984a: 440): São Tomé & Príncipe: Insula Caprarum sin. Guineensis, Ilha das Cabras, 1887, *Newton* (H-NYL 29006). It is in a rather bad condition and differs from the holotype by a comparatively thick thallus which is composed of more or less discrete areolae.

TABLE 2.—Selection of ‘species’ which have to be considered in the course of a revision of the *Rinodina oxydata* group

| Species | Important literature |
|---|--|
| <i>R. detecta</i> (Stizenb.) Zahlbr. | Mayrhofer (1984a) |
| <i>R. euskadiensis</i> A.Crespo & M.B.Aguirre | Crespo & Aguirre (1984); Giralt & Matzer (1994) |
| <i>R. fimbriata</i> Körb. | Mayrhofer & Poelt (1979) |
| <i>R. minima</i> H.Mayrhofer | Mayrhofer (1984a) |
| <i>R. minutula</i> Müll.Arg. | Mayrhofer (1984a) |
| <i>R. moziana</i> (Nyl.) Zahlbr. | Mayrhofer (1984a) |
| <i>R. oxydata</i> (A.Massal.) A.Massal. | Mayrhofer & Poelt (1979); Sheard (1967); present study |
| <i>R. schweinfurthii</i> Müll.Arg. | Mayrhofer (1984a) |
| <i>R. stellulata</i> Müll.Arg. | Mayrhofer (1984a); present study |
| <i>R. vezdae</i> H.Mayrhofer | Mayrhofer (1984a) |

9. *Rinodina reagens* Matzer & H.Mayrhofer in Acta Botanica Fennica 150: 116 (1994). Type: New Zealand, Southland, Waiau River Valley, Clifden N Tuatapere, 167°42'E, 46°02'S, limestone, 22-9-1981, H. Mayrhofer 2186, associated with *Rinodina bischoffii*, (GZU, holo.!, M, Mayrhofer, iso!).

Exs.: Plantae Gracenses Lichenes 433, as *Rinodina teichophila*.
Icons: Matzer & Mayrhofer (1994).

Thallus crustose to somewhat squamulose, rimose areolate, continuous or of discrete areolae, brown to ochraceous, smooth but sometimes covered in part by a (?lichenized) cyanobacterium (*Gloeocapsa* sp.) resulting in a coarsely warty appearance, occasionally associated with additional, filiform cyanobacteria (*Scytonema* sp.); prothallus indistinct. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 1.7 mm diam., cryptolecanorine or lecanorine and then adnate, disc reddish brown, dark brown to black, often with a narrow, pale reddish brown borderline between disc and thalline margin, plane to convex, thalline margin persistent, entire or slightly crenate. *Epihymenium* 10–30 µm tall, brown or yellowish brown, K– or K+ yellowish to orange. *Hymenium* 100–150 µm tall. *Hypothecium* to 180 µm deep, entirely hyaline, hyaline and green-yellow in parts, or entirely green-yellow, K+ yellowish to orange. *Paraphyses* 1–4 µm, apices to 6 µm wide. *Asci* corresponding to Lecanora type, 8-spored or with fewer spores. *Ascospores* (Figure 7D) with internal wall thickenings of Mischoblastia type, occasionally grading into Pachysporaria type, septum in young spores inserted before internal wall thickenings become distinct, torus absent, spores finely scabrid, with septal swellings in KOH, 22–31 × 10–19 µm. *Spermogonia* immersed in thallus, with a reddish brown, dark brown or blackish ostiolar region; in longitudinal section reddish brown to brown above, otherwise hyaline to green-yellow, K– or K+ yellowish to orange. *Spermatia* (3.5–)4.0–4.5(–5.5) × 1.5–2.0 µm.

This species is hitherto known from the Western Cape in southern Africa (Figure 6) and a few inland locations

in New Zealand (Matzer & Mayrhofer 1994). In the study area it is confined to calcareous sandstone.

A detailed discussion of the species was provided just recently by Matzer & Mayrhofer (1994) and thus, only a few notes are given here. *Rinodina reagens* is mainly characterized by the presence of a green-yellow pigment in the hypothecium, epihymenium, and in the spermogonia, which reacts K+ yellowish to orange. This pigment is not known from any other *Rinodina* species. The large ascospores without a torus are also a distinctive character which separates the taxon from almost all other *Rinodina* species known to occur in the study area. Similar spores are found in *Rinodina teichophiloides* which is closely related to *R. reagens*. These sympatric species are confined to different substrates. In South Africa *R. reagens* grows on calcareous sandstone, whereas *R. teichophiloides* is restricted to hard siliceous rocks.

Vouchers from southern Africa: *Brusse* 2874, 3852 (PRE); *J. Hafellner* & *A. Hafellner*, 30654, 30655 (Hafellner).

10. *Rinodina scabridula* Matzer & H.Mayrhofer sp. nov.

Thallus saxicola, crustaceus, rimosi-areolatus, brunneus ad griseus, blastidia formans. *Apothecia* ad 0.45 mm in diametro, lecanorina ad lecideina, immersa vel adnata; disci brunnei ad atrii, plani ad convexi. *Epihymenia* 5–20 µm alta, brunnea. *Hymenia* 60–90 µm alta. *Hypothecia* ad 150 µm alta, hyalina. *Paraphyses* 1–3 µm crassae, apicibus 3–5 µm crassis. *Asci* tholis similibus typo generis ‘*Lecanora*’ instructi. *Ascospores* (12–)15–20(–24) × (6–)7–10(–13) µm magnae, typo Milvina, Pachysporaria vel Physcia similes, toro evoluto. *Spermogonia* in thallo immersa. *Spermatia* bacilliformia, ± 4–5 × 1.0–1.5 µm magna.

TYPE.—Northern Province (Transvaal), Dist. Zoutpansberg, Louis Trichardt, near the ‘The Punch-bowl’, ± 4500 ft, on sandstone rocks, 8-10-1953, O. Almborn 6169 (GZU, holo.); 6168 (LD, iso.).

Thallus crustose, rimose-areolate, partially blastidiate, brown, grey-brown, or grey, occasionally associated with cyanobacteria; blastidia brown to dark brown, coralline when well developed, usually situated at margin of thallus areolae, rarely at thallus margin of apothecia; prothallus indistinct. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.45 mm diam., cryptolecanorine, or lecanorine to lecideine and then adnate, disc dark brown to blackish, plane to slightly convex, proper margin dark brown to blackish. *Epihymenium* 5–20 µm tall, brown. *Hymenium* 60–90 µm tall. *Hypothecium* to 150 µm deep, hyaline. *Paraphyses* 1–3 µm, apices 3–5 µm wide. *Asci* corresponding to Lecanora type, often with 8 but also with less spores. *Ascospores* (Figures 5B; 8A) of Milvina, Pachysporaria or Physcia type, or intermediate between these types, septum in young spores inserted before internal wall thickenings become distinct, torus well developed, spores smooth to finely scabrid, without septal swellings in KOH, (12–)15–20(–24) × (6–)7–10(–13) µm. *Spermogonia* immersed in thallus, ostiolar region blackish, somewhat raised. *Spermatia* ± 4–5 × 1.0–1.5 µm.

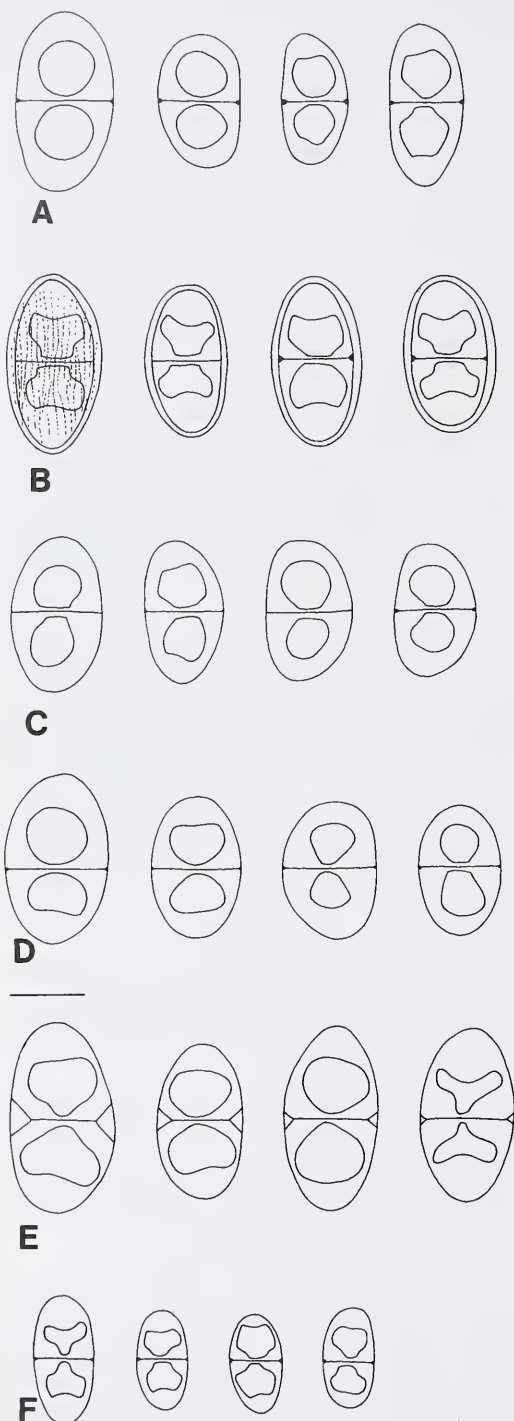


FIGURE 8.—Ascospores of southern African *Rinodina* species. A, *R. scabridula*, holotype (GZU); B, *R. striatitunicata*, holotype (GZU), on left spore striate ornamentation is indicated; C, *R. substellulata*, holotype (G); D, *R. subtristis*, lectotype (BM); E, *R. teichophiloides*, holotype (ZT); F, *R. sp. 1*, *Almborn 10610* (LD). Scale bars: 10 μ m.

Rinodina scabridula is known hitherto from two localities in the Northern Province (northern Transvaal) where it occurs on sandstone and granitic rocks (Figure 6).

Rinodina scabridula is characterized mainly by the formation of blastidia (for this term see Poelt 1980 and Giralt *et al.* 1993a, as 'Blastidien') usually at the margins of thallus areolae, and by its ascospores which are of Milvina, Pachysporaria, Physcia or intermediate type. To determine the species, careful observations are necessary as blastidia are not formed by all thallus areolae and thus, parts of the thalli are smooth. Consequently, confusion with *Rinodina subtristis* (see present study) may be possible.

Other blastidiolate, saxicolous *Rinodina* species have already been described: *R. obnascens* (Nyl.) Oliv. is a European lichen-parasitic species which is recorded growing on species of *Acarospora*, *Aspicilia*, and *Rhizocarpon* (e.g. Mayrhofer 1984a, 1987; Mayrhofer & Poelt 1979; Nimis 1993; Nimis *et al.* 1987). *Rinodina furfurea* H. Mayrhofer & Poelt which is so far known only from the type locality in South Tirol is separated from *R. scabridula* by usually shorter ascospores lacking a torus (Mayrhofer & Poelt 1979). *Rinodina blastidiata* Matzer & H. Mayrhofer is a maritime species occurring on coastal rocks in southeastern Australia and in New Zealand. It is distinguished by rather large spores ($16\text{--}32 \times 9\text{--}15 \mu\text{m}$) lacking a torus and with internal wall thickenings of Mischoblastia type, occasionally grading into Pachysporaria type (Matzer & Mayrhofer 1994). For blastidiolate *Rinodina* species growing on bark or wood see the studies of Giralt *et al.* (1993b, 1995) and Ropin & Mayrhofer (1995).

The specimen which has been selected as the isotype of *R. scabridula* in the present work was treated under *R. huillensis* by Mayrhofer (1984a).

Specimen examined

NORTHERN PROVINCE.—2329 (Pietersburg): 20 km S of Mara West Road near turnoff to Dendron, Farm Commissie Draai, grid. ref. unknown, 950–1 000 m, 23–29-1-1981, *Brusse 1628* (PRE).

11. *Rinodina striatitunicata* Matzer & H. Mayrhofer sp. nov.

Thallus saxicola, crustaceus, rimosi-areolatus, interdum effusus, brunneus ad griseus. *Apothecia* ad 0.7 mm in diametro, lecanorina ad lecideina, immersa vel adnata; disci atri, plani ad convexi. *Epihymenia* 10–20 μ m alta, brunnea ad olivacea, N– vel N+ rubescens. *Hymenia* 90–120 μ m alta. *Hypothecia* ad 170 μ m alta, hyalina. *Paraphyses* 1–3(–4) μ m crassae, apicibus (2–)3–5(–6) μ m crassis. *Asci* tholis similibus typo generis '*Lecanora*' instructi. *Ascosporae* (16–)17–27 \times (10–)11–17 μ m, ad typum *Tunicata* pertinentes, parietibus striatiformiter sculpturatis, toro non vel bene evoluto.

TYPE.—Western Cape, 3322 (Oudtshoorn): by the road from Oudtshoorn to Prince Albert, near Ombinda Karambi 7.5 km NW of the Cango Caves, (–AC), 33°23'30", 22°08'45"E, \pm 740 m, Karoo vegetation on an E-exposed slope of a hill, 20-2-1992, *J. Hafellner & A. Hafellner 30650* (GZU, holo.).

Thallus crustose, rimose-areolate, occasionally effuse, dark brown, rarely grey, occasionally somewhat rusty and rough; in longitudinal section with or without a blue-green pigment which reacts N+ red; prothallus absent. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.7 mm diam., cryptolecanorine, or lecanorine to lecideine and then adnate, disc \pm black, plane to convex, proper margin black. *Epithymenium* 10–20 μ m tall, brown to dirty olivaceous (when dirty olivaceous N+ reddish). *Hymenium* 90–120 μ m tall. *Hypothecium* to 170 μ m deep, hyaline. *Paraphyses* 1–3(–4) μ m, apices (2–)3–5 (–6) μ m wide. *Asci* corresponding to Lecanora type, with 8 or less spores. *Ascospores* (Figures 5C, D; 8B) of Tunicata type, internal wall thickenings corresponding to Physcia type, septum in young spores inserted before internal wall thickenings become distinct, torus well developed to indistinct, mature spores with striate ornamentation, (16–)17–27 \times (10–)11–17 μ m. *Spermogonia* not found.

Rinodina striatitunicata is only known from two localities in the Western Cape near the Cango Caves. It grows on volcanic conglomerate and sandstone situated in Karoo vegetation (Figure 6).

As indicated by the epithet, *Rinodina striatitunicata* is characterized mainly by ascospores of Tunicata type with peculiar striate ornamentation. The sculpture on the spore surface is elongate and more or less parallel (compare Scheidegger 1993: 335). In order to recognize the ornamentation in ascospores of *R. striatitunicata*, more or less mature or overmature spores must be studied carefully under the light microscope at a magnification of \times 1000 or more; young ascospores are more or less smooth.

Other saxicolous *Rinodina* species with Tunicata type ascospores are *R. calcarea* (Arnold) Arnold, *R. tunicata* H. Mayrhofer & Poelt (compare Mayrhofer & Poelt 1979), and *R. filsonii* H. Mayrhofer (Mayrhofer 1984b). They differ from *R. striatitunicata* in several respects and, as far as the ascospores are concerned, mainly by a microrugulate (sculpture less than 1 μ m in size, circular to elongate and irregularly arranged) instead of a striate ornamentation.

The thallus of *R. striatitunicata* varies in consistency and colour according to the rock mineralogy: a rough and rusty morphotype was found on volcanic conglomerate (Almborn 4320), whereas dark brown (to grey in small parts) and compact thalli occur on sandstone (Hafellner 30649 and 30650).

One specimen of *R. striatitunicata* (Hafellner 30649) is associated closely with small patches of another, probably undescribed *Rinodina* species which is distinguished by its pale thallus and characters of the ascospores.

Specimens examined

WESTERN CAPE.—3322 (Oudtshoorn): Dist. Oudtshoorn, 5 miles N of Cango Caves, (–AC), 31-8-1953, Almborn 4320 (LD); by the road from Oudtshoorn to Prince Albert, near Ombinda Karambi 7.5 km NW of the Cango Caves, (–AC), 33°23'30"S, 22°08'45"E, \pm 740 m, 20-2-1992, J. Hafellner & A. Hafellner 30649 (Hafellner, associated with *Rinodina* sp.).

12. *Rinodina substellulata* Müll.Arg. in Proceedings of the Royal Society of Edinburgh 11: 461 (1882). Type: Ins. Socotra, Wadi Keschin, 650 m, 1881, Schweinfurth s.n. (G, holo.!).

Lecanora substellulata (Müll.Arg.) Stizenb.: 209 (1890).

Rinodina quintana (Henriq. in Nyl.) Zahlbr.: 546 (1931). *Lecidea quintana* Henriq. in Nyl.: 24 (1889). *Lecanora quintana* (Henriq. in Nyl.) Nyl. in Hue: 55 (1891). Type: São Tomé & Príncipe, Insula Principis, 1888, Quintas s.n. (H-NYL 28854, holo.!).

Rinodina quintana var. *obscurior* (Nyl.) Zahlbr.: 546 (1931). *Lecidea quintana* var. *obscurior* Nyl.: 6 (1896). Type: Equatorial Guinea, Ins. Guineensis, Annobón [= Pagalu], 1892, F. Newton s.n. (H-NYL 10450, holo.!).

Thallus thin, crustose, areolate or effuse, pale yellowish or pale ochraceous; prothallus absent or present, blackish. *Chemistry*: thallus K+ yellow; tlc: atranorin.

Apothecia to 0.6 mm diam., cryptolecanorine, or lecanorine or lecideine and then adnate to sessile, disc brown, dark reddish brown to blackish, plane to strongly convex, proper margin black. *Proper exciple* dark brown, in addition a blue-green, N+ red pigment is often present. *Epithymenium* 10–20 μ m tall, brown, occasionally blackish green and N+ red in parts. *Hymenium* 90–110 μ m tall. *Hypothecium* to 200 μ m deep, hyaline. *Paraphyses* 1–3 μ m, apices 3–5(–6) μ m wide. *Asci* corresponding to Lecanora type, often with 8 but also with less than 8 spores. *Ascospores* (Figure 8C) of Pachysporaria type, occasionally grading into Milvina type, septum in young spores inserted before internal wall thickenings become distinct, torus often indistinct, sometimes not observable, spores smooth to finely scabrid, without septal swellings in KOH, 14–20 \times 7–12 μ m. *Spermogonia* not found.

Rinodina substellulata is known with certainty from some islands adjacent to the African continent (Príncipe and Annobón in the Atlantic Ocean; Socotra in the Indian Ocean), and from the Northern Province (northern Transvaal) and the Western Cape in the Republic of South Africa (Figure 9). It grows on hard siliceous rocks (including quartzitic rocks, sandstone, and basalt). Further records are given from Costa Rica (Stizenberger 1893), Indonesia (Mayrhofer 1984a), and Australia (Mayrhofer 1984b).

R. substellulata is characterized mainly by the K+ yellow thallus reaction (indicating atranorin) and ascospores of Pachysporaria type which may show tendencies towards Milvina type. The species is closely related to taxa of the *Rinodina oxydata* group. *Rinodina oxydata* and related species (see account of *R. oxydata* in the present study) differ from *R. substellulata* mainly by having ascospores of Mischoblastia type. *Rinodina beccariana* var. *lavicola* (J. Steiner) Matzer & H. Mayrhofer (Mayrhofer et al. 1993) shares several similarities with *R. substellulata* (e.g. K+ yellow thallus reaction, lecideine apothecia, presence of a blue-green, N+ red pigment in the apothecia, Pachysporaria type ascospores) but is separated by chemical and morphological characters: the thallus is grey to brown and contains zeorin, the apothecia are up to 1 mm in diameter, and the ascospores exhibit a wider size range (14–25 \times 7–14 μ m). In addition, the ecology and distribution of both taxa is different, with *R. beccariana* var. *lavicola* occurring on volcanic rocks near the coast or on

low coastal mountains in Macaronesia and in the Mediterranean region.

Vouchers: *Almborn* 3762 (LD, GZU); *Brusse* 1536, 1634 (PRE).

13. *Rinodina subtristis* (Nyl. in Cromb.) H. Mayrhofer in Journal of the Hattori Botanical Laboratory 55: 464 (1984a). Type: Western Cape, Cape of Good Hope, Table Mtn, September 1874, A.E. Eaton s.n., Venus Transit Expedition, (BM, lecto!., associated with *Rinodina oxydata*), designated by Mayrhofer (1984a: 464); (*H-NYL* 9329, iso.), not seen.

Lecidea subtristis Nyl. in Cromb.: 21 (1876a). *Buellia subtristis* (Nyl. in Cromb.) Zahlbr.: 421 (1931).

Thallus thin, crustose, rimose-areolate to effuse, brown or ochraceous; prothallus occasionally present, brown. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.7 mm diam., lecideine or lecanorine, adnate to sessile, occasionally cryptolecanorine, disc dark reddish brown to black, plane to convex, proper margin black. *Proper exciple* dark brown to black, in addition often with a blue-green, N+ red pigment; dead algal cells may be present. *Epithyrium* 10–20 μ m tall, reddish brown, brown, occasionally (dirty) blue-green and then partly N+ red. *Hymenium* \pm 80 μ m tall. *Hypothecium* to \pm 150 μ m deep, hyaline. *Paraphyses* 1–3(–4) μ m, apices (3–)4–6 μ m wide. *Asci* corresponding to *Lecanora* type, axial body occasionally indistinct, asci often with 8 but also with less spores. *Ascospores* (Figure 8D) of *Pachysporaria* type, occasionally grading into *Milvina* type, septum in young spores inserted before internal wall thickenings become distinct, torus small but well distinct, spores smooth to finely scabrid, without septal swellings in KOH, (15–)16–23 \times 8–16 μ m. *Spermogonia* immersed in thallus, raised, ostiolar region red-brown to blackish. *Spermatia* 3–4 \times 1.0–1.5 μ m.

Rinodina subtristis was originally known only from the Cape of Good Hope (Crombie 1876a, b; as *Lecidea subtristis*) but can now be reported also from other regions of the Republic of South Africa and from Angola (Figure 9). The species grows on hard quartzitic rocks (including quartzitic sandstone).

In addition to *R. subtristis*, there are several other *Rinodina* species in the study area which are characterized by the lack of secondary lichen compounds detectable by thin-layer chromatography and by the presence of *Pachysporaria* type ascospores with a torus, viz. *R. longisperma*, *R. microleptidea*, *R. scabridula*, and *R. confragosula*. The problematic separation of *R. subtristis* from *R. microleptidea* is discussed under the latter species in the present work. Distinctive characters of *R. longisperma* include the small cryptolecanorine apothecia, the small ascospores in which the spore lumina may have small protrusions, and the comparatively long spermatia. *Rinodina scabridula* is mainly distinguished by the formation of blastidiate thalli. The separation of *R. subtristis* from *R. confragosula* is based on a set of characters: grey thalli are often found in *R. confragosula* but never in *R. subtristis*; the apothecia of *R. confragosula* are usually purely black and cryptolecanorine but dark reddish brown to black and lecideine or lecanorine in *R. subtristis*; the as-

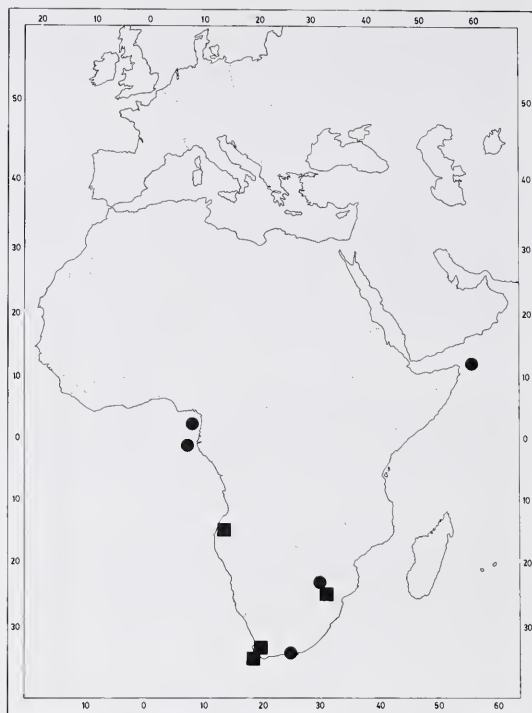


FIGURE 9.—Known distribution of *Rinodina substellulata* in Africa, ●; and *R. subtristis*, ■.

cospores of *R. confragosula* are very variable in the formation of internal wall thickenings (*Pachysporaria*, *Milvina*, *Physcia*, or intermediate types, or spore lumina irregularly biconical in shape) and in length (14–32 μ m), the spores of *R. subtristis* are usually of *Pachysporaria* type and 15–23 μ m long.

Three *Rinodina* species which were described from West African islands share close similarities with *R. subtristis*, viz. *R. praefinita* (Nyl.) Zahlbr. (Nylander 1887, as *Lecanora praefinita*) and *R. subanceps* (Nyl.) Zahlbr. (Nylander 1887, as *Lecanora subanceps*) from São Tomé & Príncipe, and *R. newtonii* H. Mayrhofer (Mayrhofer 1984a) from Annobón (= Pagalu). All these species and *R. subtristis* are known only from single or at best a few specimens, and thus statements whether these taxa are really well separated, cannot be made without some hesitation. Under this precondition, *R. praefinita* is distinguished from *R. subtristis* by smaller ascospores (\pm 13–17 \times 7–10 μ m), and *R. subanceps* differs by the thick, more or less squamulose thallus. A well-developed thallus and ascospores with an indistinct torus are characteristic for *R. newtonii*. A detailed study of the relationships between these taxa is beyond the scope of the present work and was not carried out. Mayrhofer & Leuckert (1985) recorded the presence of zeorin in a specimen of *R. subanceps* from Annobón (*H-NYL* 28964), but lichen compounds could not be detected by recent tlc-analyses in the holotype from the island of Cabras (São Tomé & Príncipe, *H-NYL* 28965) and in another specimen from Annobón (*H-NYL* 28514).

One of the specimens now regarded as belonging to *R. subtristis* was treated under *R. huillensis* by Mayrhofer (1984a): Angola, Humpata Plateau, 6-2-1960, *Degelius* (GZU).

Vouchers: *Almborn* 1720 (LD); *Brusse* 2719 (PRE); *Degelius* s.n. (GZU); *Schaefer* CH 1935 (PRE).

14. *Rinodina teichophiloides* (Stizenb.) Zahlbr. in *Catalogus lichenum universalis* 7: 557 (1931). Type: Western Cape, supra saxa quartzosa schistosa ad Muizenberg in Promontorio Bonae Spei, *MacOwan* 126 (ZT, holo.!).

Lecanora teichophiloides Stizenb.: 212 (1890).

Thallus thinly crustose to somewhat squamulose, occasionally evanescent, effuse to rimose-areolate, light greenish grey, grey-brown, dark brown, ochraceous, occasionally associated with cyanobacteria; prothallus absent or present, brown. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.8 mm diam., often with a lecideine appearance or lecanorine, immersed to adnate, (dead) algal cells sometimes present in the proper margin, disc black or dark brown, plane to convex. *Epihymenium* 10–30 μ m tall, dark brown. *Hymenium* 90–130 μ m tall. *Hypothecium* to 150 μ m deep, hyaline, light yellow to yellowish brown. *Paraphyses* 1–2 μ m, apices to 3–5 μ m wide; enlarged, to \pm 6 μ m wide ‘oil cells’ occasionally present in paraphyses. *Asci* corresponding to *Lecanora* type, 2- to 8-spored. *Ascospores* (Figure 8E) at first with internal wall thickenings of *Mischoblastia* type, then corresponding to *Pachysporaria* type, septum in young spores inserted before internal wall thickenings become distinct, torus absent but sometimes simulated by intense brown pigmentation in the septal region, spores finely scabrid, often with septal swellings in KOH, (16–)20–32 \times 10–18 μ m. *Spermogonia* immersed in thallus, raised, ostiolar region dark reddish brown to blackish. *Spermatia* \pm 4–5 \times 1.0–1.5 μ m.

Rinodina teichophiloides is a characteristic species of maritime localities in the Cape Province (Figure 10). It grows on hard siliceous rocks such as quartzitic sandstone, on inclined, vertical and overhanging rock faces. Occa-

sionally cyanobacteria were found growing at the margin of well-developed thallus areolae.

Rinodina teichophiloides was discussed in detail recently by Matzer & Mayrhofer (1994). Since then, additional material has become available and some annotations can be given on the morphology of the species. Apothecia with a lecideine appearance in surface view may contain (dead) algal cells in the proper exciple. Paraphyses with ‘oil cells’ (oil paraphyses, compare Poelt & Pelletter 1984) were observed in some specimens. The ascospores lack a typical torus but intense pigmentation in the septal region may simulate the presence of a torus. *Rinodina teichophiloides* can best be recognized by the often rather thin thallus, by apothecia often appearing to be lecideine, the large ascospores with internal wall thickenings of *Mischoblastia* or *Pachysporaria* type, and by the often coloured hypothecium which lacks a distinct colour change in potassium hydroxide. It is closely related to *R. reagens*, a species which also occurs in the Cape Province. The latter can easily be distinguished by the presence of a K⁺ reactive pigment in the hypothecium and—not always—in the epihymenium and in the spermogonia. Both the species also differ in substrate ecology (see discussion of *R. reagens* in the present study).

Vouchers: *Almborn* 926, 1235, 1262, 1280, 1320 (LD), 11498 (GZU, LD); *J. Hafellner* & *A. Hafellner*, 30656, 30658, 30659, 30661 (Hafellner), 30662 (GZU); *Kärnefelt* 8647–26 (LD); *Sipman* 20287 (B); *Triebel* & *Rambold* 7708, 8156, 8186, 8190, 8204, 8227, 8230 (M), 8156 dupl. (GZU), 8419 dupl. (GZU, M).

15. *Rinodina* sp. 1

Thallus crustose, effuse to areolate, continuous or composed of \pm discrete areolae, whitish, pale greyish, pale brownish, areolae partly convex; prothallus absent. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.45 mm diam., lecanorine, sessile, in addition to the thalline margin a proper margin is occasionally developed, disc brown to blackish, plane or concave, proper margin brown. *Epihymenium* 10–15 μ m tall, brown. *Hymenium* 60–70 μ m tall. *Hypothecium* to \pm 70 μ m deep, hyaline. *Paraphyses* 1–3 μ m, apices 2–5 μ m wide. *Asci* corresponding to *Lecanora* type, often with 8 but also with less than 8 spores. *Ascospores* (Figure 8F) of *Physcia* type, rarely grading into *Milvina* type, septum in young spores inserted before internal wall thickenings become distinct, torus small but well distinct, spores smooth to finely scabrid, without septal swellings in KOH, 11–17 \times 6–9 μ m. *Spermogonia* not found.

The species is known only from a single locality in the Eastern Cape (Figure 10).

The above description is based on the single collection cited below. In Mayrhofer (1984a) this specimen was included in *Rinodina interpolata* (Stirt.) Sheard, but we have some doubts whether it really belongs to that species. *Rinodina interpolata* usually occurs in Europe on more or less vertical or overhanging surfaces of cliffs mainly in coastal sites but also in inland localities (e.g. Fox & Purvis 1992; Mayrhofer 1984a; Mayrhofer & Poelt 1979; Santesson 1993; Sheard 1973); it was also recorded from the Antarctic region (see Lindsay 1973). A definite statement

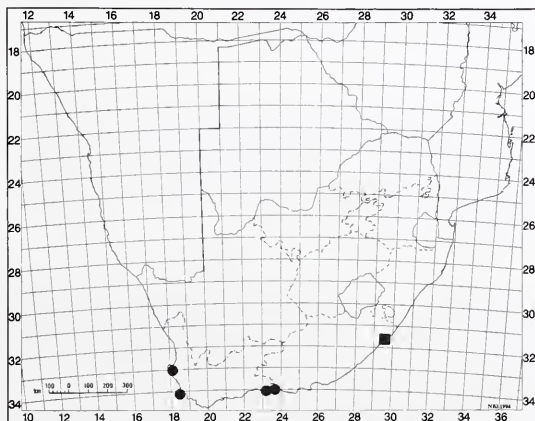


FIGURE 10.—Known distribution of *Rinodina teichophiloides*, ●, and *Rinodina* sp. 1, ■.

on the occurrence of *R. interpolata* in southern Africa only seems possible after extensive field studies and collecting of more material. Only a few significant differences between *Rinodina* sp. 1 and *R. interpolata* can be observed: the ascospores in *R. interpolata* are also of Physcia type but, particularly when older, often grade into Physconia type; in several specimens of *R. interpolata*, zeorin could be detected by tlc (hitherto unpublished data; Leuckert & Mayrhofer 1984). For a description of *R. interpolata* see Fox & Purvis (1992), Mayrhofer & Poelt (1979), and Sheard (1973).

Voucher: *Almborn 10610* (LD, associated with *Lichenodiplis lichenicola*).

EXCLUDED SPECIES

This section includes saxicolous species from southern Africa which were referred to the genus *Rinodina* by various authors, and *Rinodina* species which were erroneously recorded from the study area.

1. ***Buellia distrata*** (Nyl.) Zahlbr. in *Catalogus lichenum universalis* 7: 357 (1931). Type: Western Cape, Cape of Good Hope, Table Mtn, September 1874, *E.A. Eaton s.n.*, Venus Transit Expedition (BM, lecto.!) designated by Mayrhofer (1984a: 405), (BM, iso.!), (*H-NYL 9309*, iso.), not seen.

Lecidea distrata Nyl. in *Cromb.*: 179 (1876b). *Rinodina distrata* (Nyl.) C.W. Dodge: 167 (1971).

Thallus thin, crustose, areolate, light yellowish; prothallus blackish, between the areolae well developed. *Chemistry*: thallus K+ yellow, C-, P-; medulla K-, C+ orange, P-.

Apothecia to 0.3 mm diam., cryptolecanorine, disc black, plane. *Epiphymenium* 10–15 µm tall, brown, olivaceous to dirty greenish, N+ red. *Hymenium* 90–110 µm tall. *Hypothecium* to 100 µm deep, hyaline. *Paraphyses* 1–4 µm, apices 3–5 µm wide. *Asci* corresponding to *Bacidia* type, usually with 8, rarely with less spores. *Ascospores* (Figure 1A) of *Beltramia* type, torus absent, spores scabrid, ± 17–22 × 9–12 µm. *Spermogonia* not observed.

Buellia distrata is known only from the type specimens collected on Table Mountain on quartzitic rocks.

This species has ascospores which lack internal wall thickenings, therefore it cannot be placed within *Rinodina* as was done formerly (e.g. Dodge 1971; Mayrhofer 1984a). Alternative placements could be in either *Amandinea* Choisy ex Scheid. & H. Mayrhofer or *Buellia* De Not., two genera which are separated mainly by their spermatia: long, filiform, and curved in *Amandinea* and short, bacilliform, and straight in *Buellia* (e.g. Matzer & Mayrhofer 1993; Matzer *et al.* 1994b; Scheidegger 1993). As spermogonia are not present in the material of *Buellia distrata* now available, the best solution seems to retain the existing name of this taxon.

2. ***Buellia permodica*** (Stizenb.) Zahlbr. in *Catalogus lichenum universalis* 7: 387 (1931). Type: Western

Cape, supra saxa arenaria prope Muizenberg in Promontorio Bonae Spei, *MacOwan s.n.* (?ZT, holo.); not seen, citation after Stizenberger (1891: 168).

Lecidea permodica Stizenb.: 168 (1891).

This species was not validly transferred into the genus *Rinodina* by Dodge (1971) as reference to the basionym was omitted (ICBN, Art. 33.2.). Judging by the small spores mentioned in the protologue the species probably does not belong to *Rinodina*.

3. ***Rinodina argentiniana*** Müll.Arg. in *Flora* 72: 511 (1889).

See discussion of *Rinodina confragosula* in the present study.

4. ***Rinodina atroalbida*** (Nyl.) C.W.Dodge in *Beihfte zur Nova Hedwigia* 38: 165 (1971).

Lecanora sophodes var. *atroalbida* Nyl.: 7 (1869). *Rinodina sophodes* var. *atroalbida* (Nyl.) Zahlbr.: 552 (1931).

This taxon was described from Port Natal (Durban) in the Republic of South Africa. According to Mayrhofer (1984a) the type cannot be located.

5. ***Rinodina bicolor*** Zahlbr. in *Annales de Cryptogamie Exotique* 5: 272 (1932). Type: ?Swaziland, Mbabana, ad lapides siliceos, *V. Lebzelter s.n.* (W, holo.); not seen, citation after Zahlbruckner (1932: 273).

According to Mayrhofer (1984a) this species belongs to the genus *Buellia*.

6. ***Rinodina conspersa*** Müll.Arg. in *Flora* 72: 511 (1889). Type: Paraguay, Cerro Lambare prope Asuncion, 1882, *Lorentz s.n.* (G, lecto., iso.); not seen, citation after Mayrhofer (1984a: 484, 485).

Lecanora conspersa (Müll.Arg.) Stizenb.: 236 (1895).

The records of this species from the Zambezi River (Stizenberger 1895; Doidge 1950) are based on material of *Rinodina oxydata* (Mayrhofer 1984a).

7. ***Rinodina deminutula*** (Stizenb.) Zahlbr. in *Catalogus lichenum universalis* 7: 508 (1931). Type: Western Cape, supra saxa arenaria in Monte Leonis prope Cape Town, *MacOwan s.n.* (ZT, holo.); not seen, citation after Stizenberger (1890: 211).

Lecanora deminutula Stizenb.: 210 (1890).

Mayrhofer (1984a) pointed out that the scant type is in a poor condition and a treatment of the species is not possible.

8. ***Rinodina microphthalmia*** A.Massal. in *Memorie del Reale Istituto Veneto di Scienze, Lettere ed Arti* 10: 61 (1861).

This species was described from the Cape Province. According to the protologue it probably belongs to *Buellia*. The name *Rinodina microphthalma* was treated as a synonym of *Lecanora microps* Stizenb. by Stizenberger (1890), and of *Buellia verruculosa* Mudd by Zahlbruckner (1931).

9. *Rinodina procellarum* (A.Massal.) H.Mayrhofer in *Beihefte zur Nova Hedwigia* 79: 522 (1984b). Type: Western Cape, Caput Bonae Spei, *Wawra s.n.* (VER, holo.); not seen, citation after Mayrhofer (1984b) and Sheard (1992).

Buellia procellarum A.Massal.: 64 (1861). *Hafellia procellarum* (A.Massal.) H.Mayrhofer & Sheard in Sheard: 87 (1992).

Modern taxonomic concepts clearly suggest that this species should be included in the genus *Hafellia* Kalb, H.Mayrhofer & Scheid. (Sheard 1992).

ACKNOWLEDGEMENTS

We would like to thank the directors and curators of the herbaria who have sent type and other material on loan: B, BM, G, GZU, H, L, LD, M, PRE, TRH, TUR, W, ZT, and Dr J. Hafellner (Graz) for the provision of specimens from his private herbarium. Many thanks are also due to Dr D. Triebel and Dr G. Rambold (both Munich) who have kindly selected and provided relevant material for the present study. We are grateful to Prof. Dr C. Leuckert (Berlin) for his help with the identification of 5-O-methylthiassic acid in *Rinodina huillensis*, to Prof. Dr J. Poelt (Graz) and Prof. Dr J.W. Sheard (Saskatoon) for critical reading of the manuscript, to Dr M. Giral (Barcelona) for valuable comments and, especially, to Dr G. Kantvilas (Hobart) for correcting the English text. The 'Fonds zur Förderung wissenschaftlicher Forschung (Projekte P8500-BIO and P10514-BIO)' is acknowledged for financial support.

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FSA contributions 4: Agavaceae

G. F. SMITH* and M. MÖSSMER*

Family **Agavaceae** Endl. Enchiridion botanicum: 105 (1841) nom. cons. Cronquist: 1217 (1981).

Robust, monocarpic, usually rosulate perennials arising from short rhizome or short erect caudex. *Stem* commonly with monocotyledonous type secondary growth. *Leaves* usually crowded in basal rosette, leathery to succulent, amplexicaul, persisting for many years; each vascular bundle with well-developed fibrous cap at phloem pole. *In-florescence* apical, tall, fast-growing, terminating in a panicle, often massive. *Flowers* bisexual, actinomorphic or somewhat zygomorphic, tubular, pedicellate, trimerous throughout. *Perianth* petaloid, 3 + 3, often fleshy, united below to form a tube. *Stamens* 3 + 3; anthers mostly dorsifixed, introrse, versatile, opening by longitudinal slits, linear to oblong. *Ovary* trilobular, inferior, with septal nectaries, placentation axile, ovules in 2 vertical rows in each locule; style terminal, stigma 3-lobed. *Fruit* a loculicidal capsule. *Seeds* numerous, flattened, centrally embedded in copious, very hard endosperm. *Chromosome numbers*: $2n = 60, 120, 149, 150, 180$ (Bolkhovskikh *et al.* 1969).

When the plan for the *Flora of southern Africa* was first published in 1963, it did not include the Agavaceae as currently circumscribed. Two representatives of the genus *Agave* L., *A. americana* L. and *A. sisalana* Perrine, are naturalized in South Africa, and the family as defined here warrants inclusion in the *FSA* series.

The Agavaceae is a family of about 12 genera and 400 species, occurring mostly in the New World tropics and subtropics, and India to Australia (*Cordylina* Comm. ex R.Br.). Numerous genera are cultivated in southern Africa by collectors and in amenity horticulture, but only two species of *Agave* are naturalized. The boundaries and content of this heterogeneous family is still debated; the circumscription upheld here follows Brummitt (1992), which approximates the interpretation of Cronquist (1981).

1219000 AGAVE

Agave L., Species plantarum 1: 323 (1753); Trelease: 231 (1914); Berger: 21 (1915); Gentry: 41 (1972); Gentry: 10 (1978); Gentry: 61 (1982); Pedley & Forster: 72, 74 (1986); Couper & Cullen: 278 (1988). Type: *A. americana* L.

Description as for family.

Agave is a New World genus of ± 275 species. One introduced species, *A. americana* L., is naturalised around sites of habitation, mainly in the more arid, karroid regions

of southern Africa. A second species, *A. sisalana*, has been used as a barrier plant during South Africa's border war and for fibre production in plantations in various—mainly summer rainfall—savanna regions of the subcontinent. This species has also subsequently become naturalized in South Africa. Both species are included in catalogues of problem plants in southern Africa (Wells *et al.* 1986; Henderson 1995). Distribution maps for the species (Figures 1 & 2) are based on those included in Henderson (1995). Additional attempts to obtain a clearer picture of naturalized distribution, uses and history of *Agave* in southern Africa are being made (Smith 1995a, b; Smith & Crouch 1996).

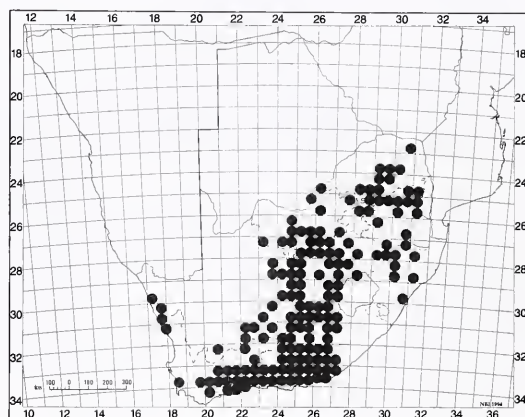


FIGURE 1.—Distribution map of *Agave americana* in southern Africa.

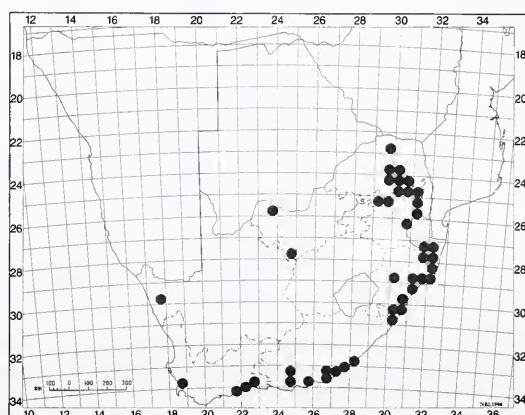


FIGURE 2.—Distribution map of *Agave sisalana* in southern Africa.

*National Botanical Institute, Private Bag X101, Pretoria 0001.
MS. Received: 1995-04-24.

The name *Agave* was taken from the Greek, *aganos*, which means noble or admirable.

Key to species in southern Africa

- Leaves lanceolate, reflexed, usually glaucous green, up to 2 m long; marginal teeth present on mature leaves, straight or recurved; panicle not bulbiferous; flowers 70–100 mm long *A. americana*
- Leaves ensiform, rigid, usually light to dark green, up to 1.3 m long; marginal teeth absent from mature leaves; panicle bulbiferous after flowering; flowers 55–65 mm long *A. sisalana*

1219000-00100 *Agave americana* L., Species plantarum 1: 323 (1753); Berger: 151 (1915); Gentry: 278 (1982); Pedley & Forster: 74 (1986); Couper & Cullen: 280, 281 (1988). Type: 'America calidiore' specimen 443.1 Herb. Linnaeus [LINN, holo. non vidi; fide Gentry: 278 (1982)].

Agave complicata Trel. ex Ochot.: 100 (1913).

A. gracilispina Engelm. ex Trel.: 234 (1914).

A. melliflua Trel.: 234 (1914).

A. zonata Trel.: 234 (1914).

A. felina Trel.: 128 (1920). Type: Durango, *Trelease s.n.* (MO, holo.) non vidi.

A. rasconensis Trel.: 122 (1920). Type: San Luis Potosi, Rascón, *Trelease 75* (MO, holo.) non vidi.

A. subzonata Trel.: 129 (1920). Type: Nuevo Leon, Monterrey, *Trelease s.n.* (MO, holo.) non vidi.

Herbaceous, succulent multi-annual, freely suckering; rosettes trunkless, 2–4 m in diameter, 1–2 m tall. *Leaves* lanceolate to oblanceolate-spathulate, rigidly spreading to reflexed, 1–2 × 0.3 m, light green to (more commonly) glaucous grey-green; surfaces smooth; margins sinuous-toothed, teeth straight or sometimes slightly recurved, shiny blackish brown to grey, 5–10 mm long, 20–60 mm apart; apical spine conical to subulate, 30–50 mm long, shallowly grooved above for ± half its length, brown to grey. *Inflorescence* paniculate, 4–9 m tall, with up to 35 umbellate side branches in upper half of peduncle. *Flowers* light greenish yellow, 70–100 mm long. *Perianth* with tepals subequal in length but of more or less similar shape, spatulate, slender, outer segments cucullate at tip, 25–35 mm long. *Stamens* epipetalous; filaments subulate, 60–90 mm long; anthers yellow, 30–40 mm long. *Ovary* oblong-ovoid, broadly trigonal, indistinctly 6-grooved, sessile, 30–45 mm long; style filiform, at length longer than filaments; stigma capitate, apical, becoming well exerted, usually considerably exceeding anthers after anthesis. *Capsule* oblong, short-beaked, 40–60 × 20–30 mm. *Seeds* 6–9 × 5–7 mm. *Chromosome numbers*: 2n = 60, 120, 180 (x = 30) (Granick 1944). Figure 3.

The species comprises one subspecies and seven varieties (excluding the typical subspecies and variety). One of these, *Agave americana* (subsp. *americana*) var. *americana*, has become naturalised in southern Africa. The widely cultivated *A. americana* var. *picta* which has variable yellow or whitish leaf striations has not been as successful in colonizing suitable habitats in southern Africa, and only the typical variety is regarded as naturalized.

The form of *A. americana* which is naturalized in southern Africa is morphologically and chorologically remarkably uniform, as though from a single clone. The little variation encountered during field observations occurs primarily in the size of plants, depending on age, crowding, or on individual sites. A form with light glaucous green, stiff leaves is sometimes encountered, particularly between Montagu and Ouberg Pass in the southwestern Cape. *A. americana* flowers in midsummer (late December, January and early February) in southern Africa.

In times of drought in some areas of the Great Karoo the leaves of cultivated plants are cut and used as forage for sheep. Honey produced from the nectar of *A. americana* has an unpleasant taste.

A. americana occurs in Arizona and Texas in the southern United States of America and in Baja California Sur, Chihuahua, Coahuila, Durango, Hidalgo, Jalisco, Nuevo Leon, Oaxaca, Queretaro, San Luis Potosi, Tamaulipas, Vera Cruz and Zacatecas in Mexico (see Gentry 1982: 305, 306 for a more complete list of exsiccatae of *A. americana*, including its varieties). *A. americana* is a complex species that has been misunderstood by some authors (Drummond 1910; Gentry 1982). The polymorphic nature of *A. americana* is evidenced by the numerous infraspecific segregates that have been described. It is generally interpreted as a phylogenetically advanced species in the section *Americanae* of the genus (Gentry 1982: 270).

Voucher: G. F. Smith 241 (PRE).

Icons: Gentry: figs 2.8B, 12.6 & 12.7 (1982); Ullrich: figs 1–62 (1993).

Common names: English: agave, American agave, American aloe, century plant. Afrikaans: Amerikaanse aalwee, Amerikaanse aalwyn, blou-aalwee, gareboom, garingboom, kaalgaarboom, makaalwyn. Sotho: lekhala.

1219000-01300 *Agave sisalana* Perrine in United States of America 25th Congress, 2nd session, House of Representatives Report No. 564 (Tropical Plants): 8, 9, 16, 47, 60, 86 (1838a); Perrine: 36, 105, 140 (1838b); Trelease: 49 (1913); Berger: 230 (1915); Gentry: 628 (1982); Pedley & Forster: 75 (1986); Couper & Cullen: 282 (1988). Type: Ososocautla, Chiapas, Mexico, 22 March 1957, H. S. Gentry 16434 [US, DES, neo. non vidi; fide Gentry: 628 (1982)].

Herbaceous, succulent multi-annual, freely suckering; rosettes with a trunk of up to 1 m, rosettes 2–3 m in diameter, 1–2 m tall. *Leaves* narrowed towards base, narrowly oblanceolate, rigidly spreading to slightly reflexed, 1–2 × 0.3 m, light green to (more commonly) dark grey-green; surfaces smooth; mature leaves without marginal teeth, young leaves with few minute teeth; apical spine conical to subulate, 30–50 mm long, brown to grey. *Inflorescence* paniculate, 4–9 m tall, with up to 40 umbellate side branches in upper half of peduncle; bulbils borne in axils after flowering. *Flowers* yellow, 55–65 mm long. *Perianth* with tepals equal in length, cucullate at tip, 17–18 mm long. *Stamens* epipetalous; filaments subulate, 60–90 mm long; anthers yellow, 30–40 mm long. *Ovary* green, oblong-ovoid to globose, broadly trigonal, 6-grooved, sessile, 30–45 mm long; style filiform, at length

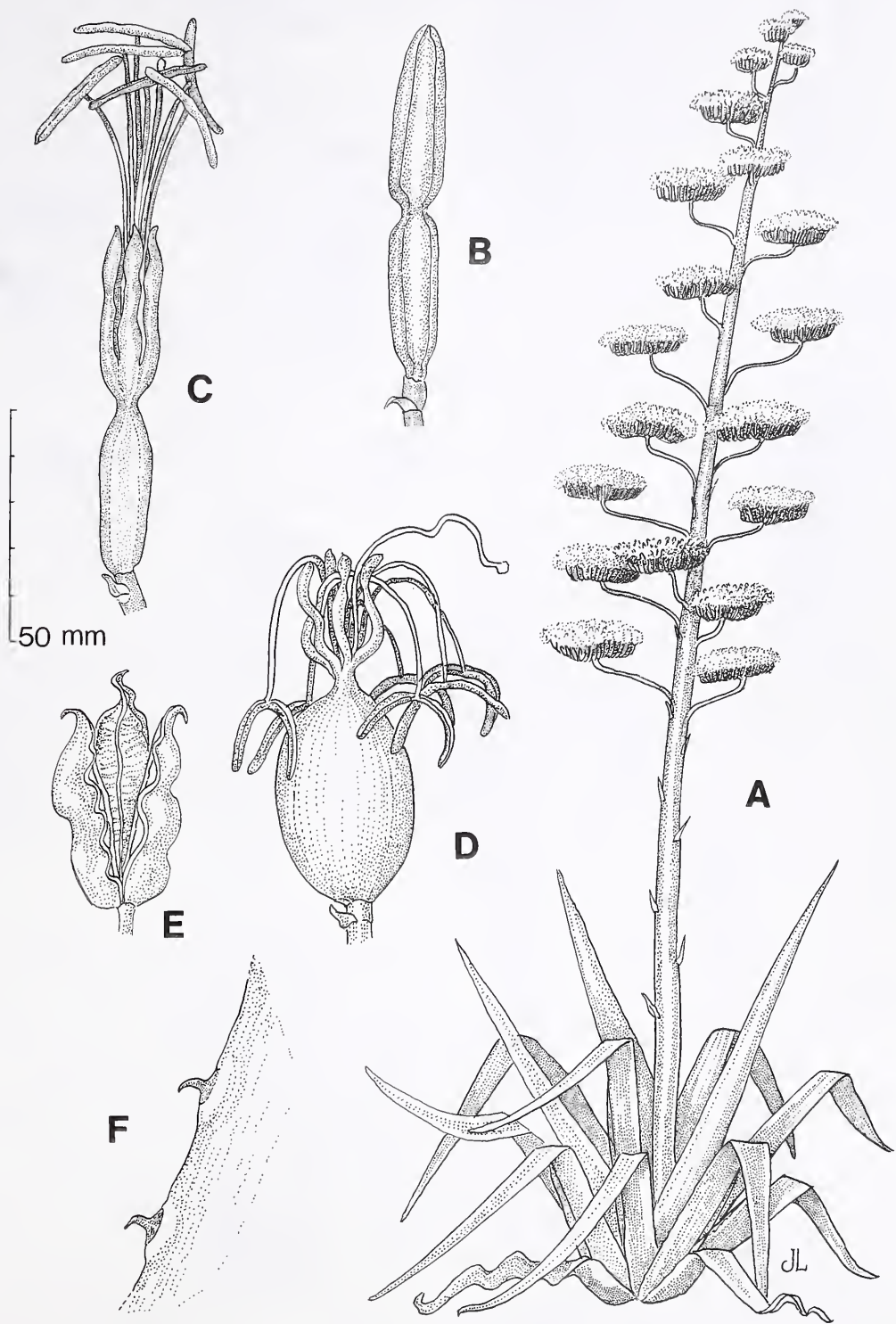


FIGURE 3.—*Agave americana*: A, habit, inflorescence 7m tall; B, bud, $\times 1$; C, protandrous flower in male phase, $\times 1$; D, developing fruit, $\times 1$; E, dry capsule, $\times 1$; F, leaf margin showing recurved teeth, $\times 1$. All drawings made from live material collected by G. F. Smith and E. J. van Jaarsveld, deposited under *G. F. Smith 241* (PRE). Artist: Jeanette Loedolff.

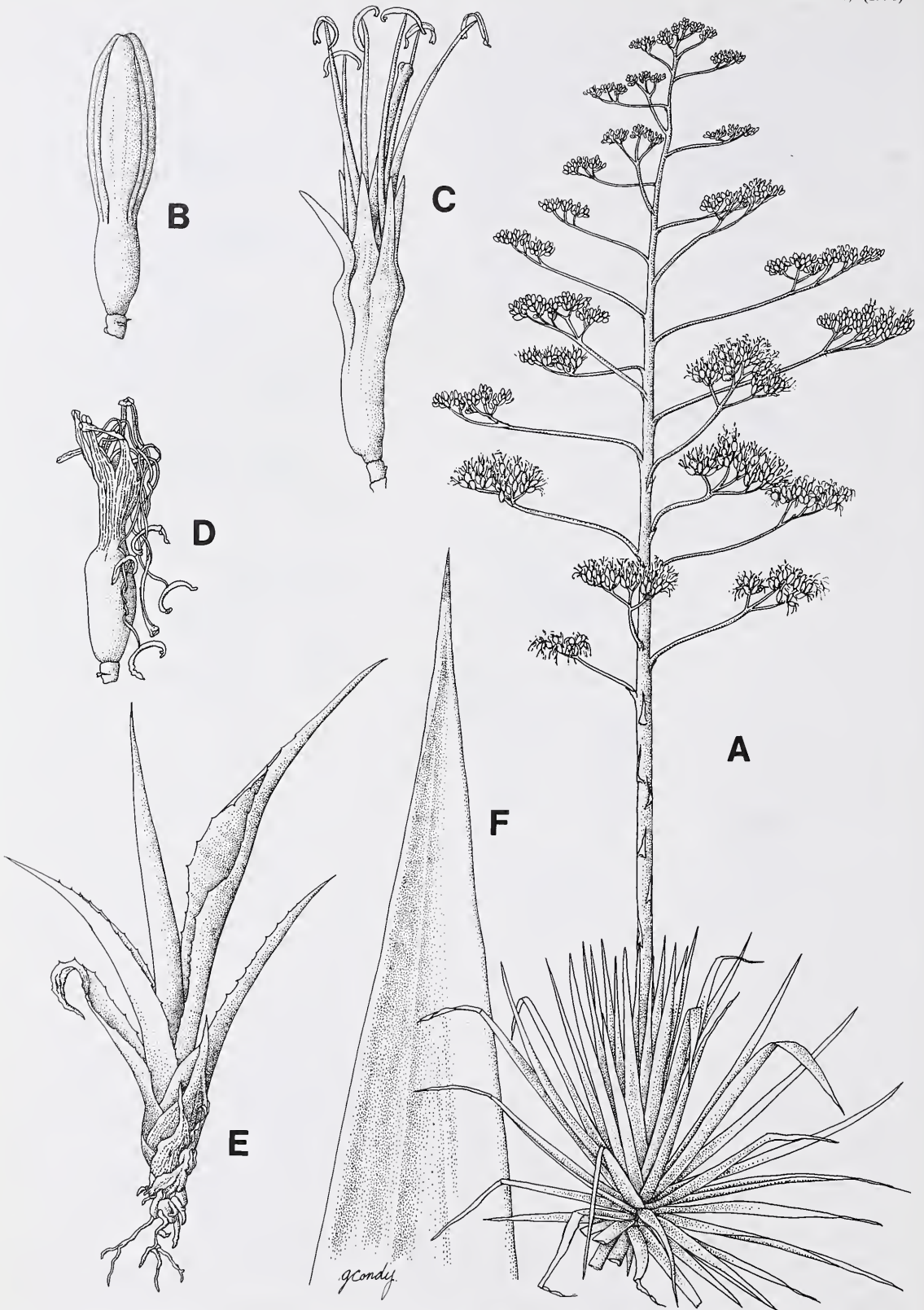


FIGURE 4.—*Agave sisalana*: A, habit, inflorescence 7m tall; B, bud, $\times 10$; C, protandrous flower in male phase, $\times 10$; D, wilted flower, $\times 10$; E, plantlet formed on side branch of inflorescence (note small teeth on leaf margin), $\times 10$; F, terminal portion of leaf (note entire leaf margin), $\times 10$. All drawings made from live material deposited under G. Condry & G. F. Smith 1 (PRE). Artist: Gillian Condry.

longer than filaments; stigma capitate, minute, apical, becoming well exerted, usually considerably exceeding anthers after anthesis. *Capsule* and *seeds* generally lacking. *Chromosome numbers*: $2n = 149, 150$ (Granick 1944; Banerjee & Sharma 1987).

A. sisalana is a sexually sterile clone, probably of hybrid origin. This is demonstrated by its inability to produce seed and its pentaploid chromosome complement (Granick 1944; Gentry 1982). Although Gentry (1982: 628, 630) argues that *A. sisalana* might have been introduced to various parts of the world from the Mexican state of Chiapas (the small towns from Cintalapa to Chiapa), its origin remains uncertain. Gentry (1982: 634) lists a number of *A. sisalana* exsiccatae, many of them having been collected from areas to which the 'species' has been introduced. Agave fibre industries—based primarily on this species—were developed in the Philippines and Indonesia in the previous century, and more recently in East Africa (Doughty 1937, 1938; Gentry 1982). Figure 4.

Voucher: *G. Condy & G. F. Smith 1* (PRE).

Icones: Doughty: fig. 2 (1937); Gentry: fig. 22.9 (1982).

Common names: English: hemp plant, sisal, sisal hemp. Afrikaans: garingboom.

ACKNOWLEDGEMENTS

We thank Judge Selikowitz for permission to collect flowering material of *Agave americana* for description and illustration from his garden in Edinburgh Drive, Claremont, Cape Town. We are indebted to Dr Peter Goldblatt, Missouri Botanical Garden, Ms Marinda Koekemoer, former South African Botanical Liaison Officer at Kew, and Mr Bernd Ullrich, Pohlheim, for providing us with useful documentation. Ms Lesley Henderson, Plant Protection Research Institute, kindly made distribution data available.

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FSA contributions 5: Buxaceae

H.F. GLEN*

Monoecious evergreen shrubs or small trees. *Leaves* opposite, simple, shortly petiolate, entire; stipules 0. *Inflorescences* compact axillary racemes or cymes, sessile or shortly pedicelled. *Flowers* radially symmetrical, unisexual, small; perianth of 2 sepaloïd whorls. *Male flowers*: perianth lobes 4, imbricate; stamens 4–8, opposite perianth lobes, filaments free, anthers dorsifixed near base, 2-theous. *Female flowers*: perianth lobes 4–6, imbricate; ovary superior, 3-locular with 2 pendulous ovules per locule, styles 3, usually distant. *Fruit* a loculicidal, 3-horned capsule. *Seeds* glossy black, triangular in section.

A mainly northern hemisphere family of four genera and about 100 species. One genus with two species occurs naturally within the area of the *Flora of southern Africa*. In addition species of the genera *Sarcococca*, *Pachysandra* and *Simmondsia* (this last often regarded as constituting a separate family) are sometimes cultivated here.

4533000 BUXUS

Buxus L., Species plantarum 983 (1753); Hutch.: 375 (1915); Marloth: 142 (1925); Hutch.: 108 (1967); R.A.Dyer : 326 (1975). Type species: *B. sempervirens* L.

Buxella Tiegh.: 326 (1897). No type cited.

Notobuxus Oliv.: t. 1400 (1882); Hutch.: 376 (1915); E.Phillips: 138 (1943); E.Phillips: 470 (1951). Type species: *N. natalensis* Oliv.

Description as for family.

- 1a Bark longitudinally fissured, greenish brown; twigs angled; leaves 12–40 × 6–18 mm, apex obtuse . . . 1. *B. macowanii*
1b Bark rough, pale brown; twigs grooved; leaves 50–100 × 20–50 mm; apex with a drip tip 2. *B. natalensis*

A mainly north temperate genus of some 80 species, two of which occur naturally in our area. In addition, *B. sempervirens* is occasionally cultivated here; PRE has specimens from Tokai (Western Cape), Cedara (Kwazulu-Natal) and Roodeplaat (Gauteng).

Friis (1989) discusses the generic delimitation of the African species in some detail, and supports the conclusion that while *Notobuxus* is a good subgenus, it cannot be recognised as generically distinct from *Buxus*.

1. ***B. macowanii*** Oliv. in Hooker's Icones plantarum 16: t. 1518 (1886); Sim: 321 (1907); Hutch.: 55 (1912); Hutch.: 375 (1915); Palmer & Pitman: 1183 (1973); E.S.Pooley: 238 (1993). Type: Kwelegga Forest, *Hutchins*

in MacOwan (*Herbarium Normale Austro-Africanum*) 916 (K, lecto., here designated; BOL!, NBG!, isolecto.).

Buxella macowanii (Oliv.) Tiegh.: 326 (1897).

Notobuxus macowanii (Oliv.) E.Phillips: 140 (1943).

Tree 4–9 m tall, ± glabrous; stem straight, slender; bark greenish brown, longitudinally fissured; branchlets angled. *Leaves* opposite, narrowly rhombic-elliptic to ovate-oblong, 12–40 × 6–18 mm, apex obtuse, sometimes minutely apiculate, base cuneate, stiffly coriaceous, dark green, shiny; in seedlings and juvenile specimens leaves very narrowly linear. *Inflorescences* ± sessile axillary raceme; flowers very small, greenish. *Male flowers* clustered at base; perianth lobes 4; stamens 4–6, filaments free; pistillode minute. *Female flowers* apical or on separate inflorescences; perianth lobes 4–6; ovary 3-locular; styles 3. *Fruit* a loculicidal, 3-horned, greenish brown capsule, ± 7 mm in diameter. *Seeds* glossy black, triangular in section, ± 5.0 × 2.5 × 2.5 mm. Flowering July–October; fruiting February to June. Figure 1.

Widespread from Eastern Cape to the North-West Province and Mpumalanga (Eastern Transvaal). Figure 2.

Vouchers: Abbott 87; W.F. Barker 10902; Codd 10512; G.K. Theron 2161; H.J.T. Venter 5226.

Oliver (1886) records in the protologue that this species is described from several gatherings made by Hutchins, and sent to Kew by MacOwan. This implies the existence of several syntypes, none of which is specified precisely. Hutchinson (1912) mentions only one of these, namely *Hutchins in MacOwan 916*. This implicit acceptance of this specimen as lectotype is here made explicit.

Sterile plants of this species are similar in habit and leaf size and arrangement to *Carissa bispinosa* (L.) Desf. ex Brenan, but the latter has conspicuous branched thorns, whereas *Buxus* species are unarmed. The leaves of *B. sempervirens* are similar in size and shape to those of *B. macowanii*, but in the exotic species the midribs and a marginal vein are much more prominent, especially beneath.

The Xhosa name *garagara* is recorded for this species by Oliver (1886); the specimen *Archibald 5409* (BOL) gives the alternative spelling *gala-gala*. Palmer & Pitman (1973) record, in addition to the other common names noted in this paragraph, the names *Buig-my-nie* (Afrikaans), *umGalagala* and *umNgquzu* (Zulu). The specimen *F. Venter 2000* (PRE) records the Tswana common name *mupshane*. Marloth (1925) gives the common name *Cape box*, noting that the wood of *Gonioma kamassi* E.Mey. was exported under the same name. He records that the wood of *Buxus macowanii* is almost as suitable for making woodcuts for printing as that of the European *B. sempervirens*, but that logs are inclined to split while drying.

* National Herbarium, Private Bag X101, Pretoria 0001.
MS received: 1994-02-08.



FIGURE 1.—*Buxus macowanii* Oliv.: A, branch $\times 0.9$; B, open capsule, $\times 0.9$; C, broad-leaved form, $\times 0.9$; D, cluster of one female and two male flowers, $\times 2.5$; E, male flower, $\times 4.3$; F, female flower, $\times 4.3$. Taken from Sim (1907).

In the National Tree List (Von Breitenbach 1995) this tree is No. 358, with standard names *Kaapse buksboom* and *Cape Box*.

Although the first published record of this species dates from 1886, the first written account of it known to the present author is some 60 years older. This is a curious handwritten account by C.H. Wehdeemann (see entry under this name in Gunn & Codd 1981) of a group of trees on a farm near Somerset East, Eastern Cape. This account forms part of a set dated 1 August 1826; if Wehdeemann had published his notes, this tree would have quite a different name today.

2. *B. natalensis* (Oliv.) Hutch., Genera of flowering plants 2: 108 (1967); Palmer & Pitman 2: 1185 (1973); E.S.Pooley 238 (1993). Syntypes: Natal, Inanda, Wood 1357 (NH, K, BOL!); Natal, Tongaat, Cooper 3465 (K).

Notobuxus natalensis Oliv.: t. 1400 (1882); Sim: 320 (1907); Hutch.: 55 (1912); Hutch.: 376 (1915).

Shrubs or small trees 1–3(–5) m tall, \pm glabrous; main stem straight, slender; bark rough, pale brown; young

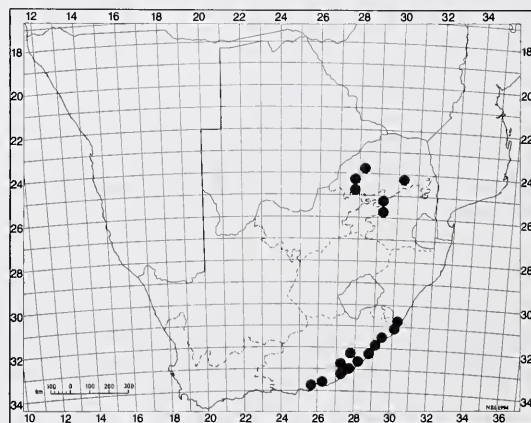


FIGURE 2.—Distribution of *Buxus macowanii* Oliv.



FIGURE 3.—*Buxus natalensis* (Oliv.)
Hutch.: branch with flowers and
fruit, $\times 0.9$.

stems bright green, grooved. *Leaves* opposite, shortly petiolate, elliptic, $50\text{--}120 \times 20\text{--}50$ mm, apex with a drip-tip, base cuneate; midrib prominent below; thinly coriaceous, dark green, shiny; petiole 2–6 mm long. *Inflorescences* \pm sessile axillary clusters with both male and female flowers; flowers small, white, pale grey, green or yellow. *Male flowers*: perianth lobes 4; stamens 4–8, filaments free; pistillode minute. *Female flowers*: perianth lobes 4–6; ovary 3-locular; styles 3. *Fruit* a loculicidal, 3-horned, greenish brown capsule, ± 12 mm in diameter. *Seeds* glossy black, triangular in section, $\pm 7 \times 3 \times 3$ mm. Flowering August–September; fruiting September–December. Figure 3.

Endemic to KwaZulu-Natal and adjacent Transkei, mostly coastal. Figure 4.

Vouchers: Abbott 214; A.W. Bayer 767; C.J. Ward 7153; Wells 3502; White 10631.

Palmer & Pitman (1973) record the common names *Natal box*, *iGalagala* and *ukuXeza* (Xhosa), *umGalagala*,

umHlulambazo, *umPhicamaguma* and *umMgquzu* (Zulu) for this tree. In the National Tree List (Von Breitenbach

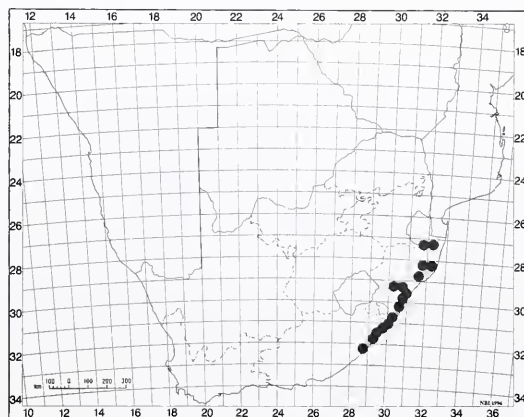


FIGURE 4.—Distribution of *Buxus natalensis* (Oliv.) Hutch.

1995) this is No. 359, with standard names *Natalse Buksboom* and *Natal Box*.

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Notes on African plants

VARIOUS AUTHORS

CELASTRACEAE

CORRECT ORTHOGRAPHY AND AUTHOR CITATION FOR *ELAEODENDRON*

Disagreement exists in the literature as to the correct form and author citation of the generic name *Elaeodendron*. Some sources refer to the taxon as *Elaeodendron*, with Jacq. f. (also abbreviated J.F. Jacq. or J. Jacq.) as validating author (Bentham & Hooker 1862; Loesener 1942; Brummitt 1992; Greuter *et al.* 1993; Green 1994), whereas others attribute the name to Jacq. or Jacq. f. ex Jacq. (Robson 1966; Villiers 1975; Proctor 1984; Robson *et al.* 1994). Kostermans (1986) argues that *Elaeodendrum* Murray (1784) has priority over *Elaeodendron* Jacq. f. (1787), and is therefore the correct name, a practice followed by, for example, Loesener (1907, 1926) and Britton & Millspaugh (1962). Jacquin f. (1787) introduced yet another variant by referring to the genus in the genitive case, namely *Elaeodendri*.

Elaeodendron was first published in 1782, without description, as a colour plate labelled *Elaeodendron orientale* and bound in the first volume of the elder Jacquin's three-volumed *Icones plantarum rariorum* (Figure 1). The colour plates of this work were issued in fascicles of 25, in an order unrelated to that in which they were eventually bound. The publication date and composition of each fascicle have been reviewed by Schubert (1945). *Elaeodendron orientale* (plate no. 48) formed part of fascicle 2 and was published in 1782. The text accompanying the plates of this fascicle was published a few years later, possibly in 1787 (Schubert 1945).

As source for the generic name *Elaeodendron*, the elder Jacquin (in both the text and plate bound with Vol. 1 of his *Icones*) referred to a then still unpublished manuscript of the younger Jacquin, intended for publication in *Acta Helvetica Physico-Mathematico-Botanico-Medica* Vol. 9. This series was apparently discontinued after Vol. 8 (Ingram 1966; Lawrence *et al.* 1968; Burdet *et al.* 1980), a deduction supported by the fact that no reprint of any further volumes has been found in Jacquin's library at WU, or anywhere else (Stafleu & Cowan 1979). Eventually, in 1787, the younger Jacquin's manuscript was published in the solitary issue of a new series, *Nova Acta Helvetica Physico-Mathematico-Botanico-Medica*, thus providing a description of *Elaeodendron*, albeit with the name in the genitive case as *Elaeodendri*. Although some workers (Farr *et al.* 1979; Stafleu & Cowan 1979; Howard 1989) proposed an earlier publication date (1780–1784) for this new series, evidence is overwhelmingly in favour of 1787 (Lawrence *et al.* 1968). Note, however, that some authors have erroneously attributed the contribution in *Nova Acta Helvetica Physico-Mathematico-Botanico-Medica* to the elder Jacquin, rather than to his son (Robson *et al.* 1994).

As was the case with the elder Jacquin, Murray (1784) had access to the younger Jacquin's manuscript and, al-

though not intending to publish the genus, provided a brief description of it under the name *Elaeodendrum*. Thus Murray's description of the generic name pre-dates those of the elder and younger Jacquin by about three years. Should Murray then not be credited as the validating author of the generic name for the taxon under discussion, as suggested by Kostermans (1986)?

According to Art. 42 of the Tokyo Code (Greuter *et al.* 1994), *Elaeodendron* should, despite the lack of a description, be considered validly published just on the basis of the colour plate in the *Icones plantarum rariorum*, Vol. 1, t. 48 (1782). This plate meets the requirement for valid



FIGURE 1.—Copy of colour plate of *Elaeodendron orientale* Jacq. published in N.J. Jacquin's *Icones plantarum rariorum* Vol. 1 (1782). Note name of taxon and reference to *Acta Helvetica* Vol. 9. Elongated leaves on juvenile branch are typical of species.

publication in containing an analysis (defined in Art. 42.4 of the Code as a figure or group of figures, ... showing details aiding identification,...') and a binomial appearing in print on it (Art. 42.3). The author citation of *Elaeodendron* is therefore correctly referred to as Jacq. (or Jacq. f. ex Jacq.). Recently, Brummitt & Powell (1992) proposed J. Jacq. as abbreviation for the younger Jacquin.

The elder Jacquin's 1787 text accompanying his 1782 plate of *E. orientale*, consists of a mere list of the parts of the illustration in Latin, but is, as in the case of the work of Murray (1784) and Jacquin f. (1787), irrelevant in terms of the Code. Arguments for accepting *Elaeodendrum* Murray as the correct generic name are therefore not valid. *Elaeodendrum* and *Elaeodendri* are to be treated merely as orthographical variants and should be corrected (Art. 61). Although the genus is often included in *Cassine* L. s.l., a stricter delimitation of the genera, including the recognition of *Elaeodendron* Jacq., has recently been advocated (Archer & Van Wyk 1993a, b).

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R.H. ARCHER* & A.E. VAN WYK**

*National Botanical Institute, Private Bag X101, Pretoria 0001.

**H.G.W.J. Schweickerd Herbarium, Department of Botany, University of Pretoria, Pretoria 0002.

MS. received: 1995-05-26.

CROTALARIEAE

RARE OR EXTINCT SPECIES OF ARGYROLOBIUM

While revising *Argyrobolium* for South Africa, three taxa which are known from single collections were recognised. Perhaps these species will join a burgeoning list of extinctions for southern Africa. It is hoped that the publication of this paper will alert collectors and disprove this assertion.

1. *Argyrobolium crinitum* (E.Mey.) Walp. in Linnaea 13: 506 (1839); Walp.: 630 (1843); Benth.: 340 (1844); Harv.: 68 (1862). Type: Western Cape, Swartberge, Trado, Drège 6627 (K; P!).

Chasmona crinita E.Mey.: 71 (1836).

Suffrutex up to 600 mm tall, forming clumps, branched basally; stems annual, rufous-pilose. *Leaves* pilose; leaflets ovate to obovate, 30–50 × 14–23 mm, apex rounded; petiole 10–20 mm long, adaxially canaliculate; stipules 20–40 × 18–24 mm, amplexicaul, apex usually 4-lobed. *Inflorescence* elongate, terminal; bracts obovate, 13 × 5 mm; bracteoles 2.00 × 0.75 mm, filiform. *Calyx* pilose, deeply bilabiate; upper lobes 6 mm long, upper sinus 4.5 mm deep, lower lip 8 mm long, lobes acute, 3 mm long. *Corolla* yellow; standard suborbicular, strongly reflexed, 8 × 8 mm, adaxial surface sparsely sericeous medially, claw canaliculate, 4 mm long; wings oblong, 9 × 4 mm, glabrous, claw 4 mm long, sculpturing in the lower basal

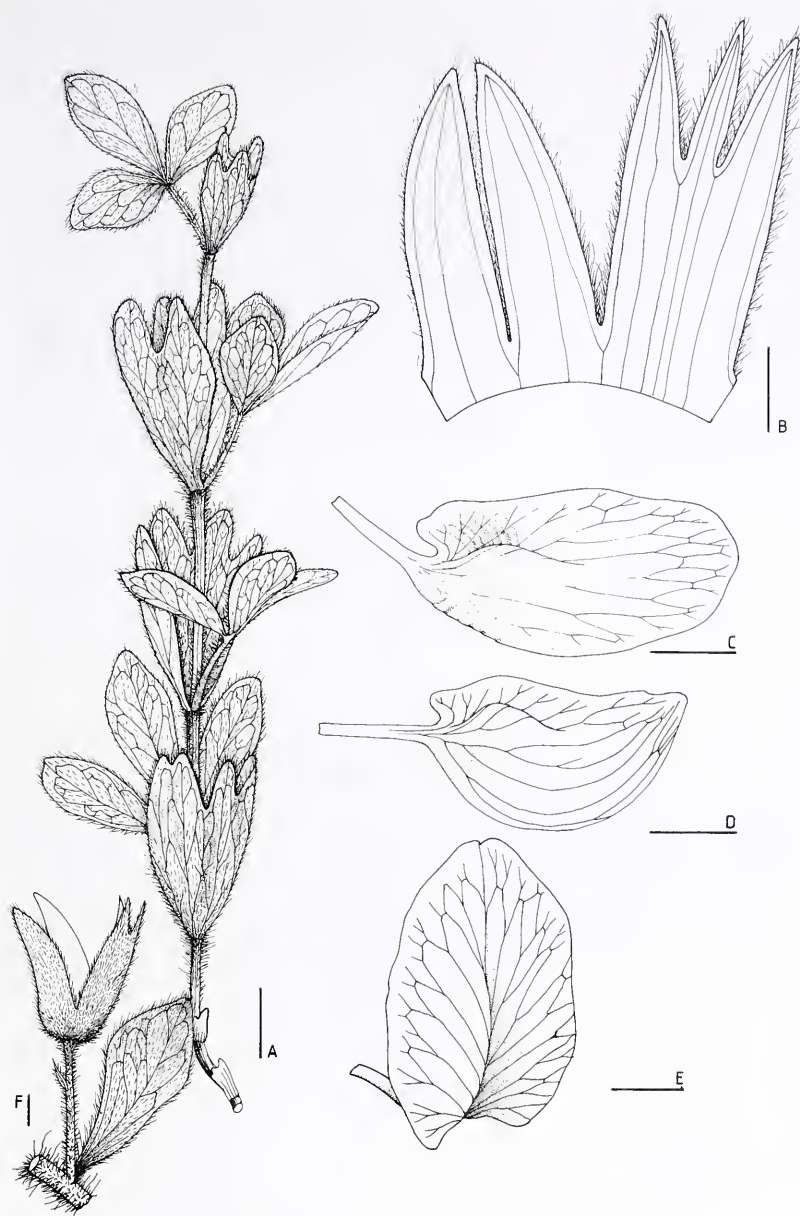


FIGURE 2.—*Argyrolobium crinitum*, Drège s.n. A, vegetative branch; B, calyx; C, wing; D, keel; E, standard; F, calyx, pedicel and bract. Scale bars: A, 20 mm; B–F, 2 mm.

and upper basal zones; keel cymbiform, 7×4 mm, claw 5 mm long. *Stamens* monadelphous, sheath split above. *Ovary* narrowly oblong, 9 mm long, densely rufo-sericeous, 6-seeded; style 4 mm long. *Fruit* and *seed* unknown.

A. crinitum (Figure 2) is a distinctive species with large, 4-lobed stipules. Its distinctive morphology led Meyer (1836) to suggest that it may represent a new genus. The closest ally is undoubtedly *A. amplexicaule* (E.Mey.) Dummer which has similar leaves, stipules and vestiture. The species are allopatric with *A. amplexicaule* commonly occurring in grasslands of the Eastern Cape and KwaZulu-Natal.

Only a single flower of *A. crinitum* was available for examination and details of inflorescence structure were

therefore taken from Meyer (1836). The calyx has a truncate base and the petals have well-developed claws, features unusual for *Argyrolobium*. The fusion of the filaments, the dimorphic anthers and the calyx lobing, however, support its generic placement.

WESTERN CAPE.—3320 (Montagu): Swaartberge, Trado, (–DC), Drège 6627 (K, P).

2. *Argyrolobium splendens* (Meisn.) Walp., Repertorium botanices systematicae 2: 845 (1843); Benth.: 348 (1844); Harv.: 76 (1862). Type: Western Cape, mountainsides around Klein Rivier, Swellendam, Krauss 927 (B†; NY!, lecto. selected here; G!, MO!, W!, isolecto.).

Chasmone splendens Meisn.: 78 (1843).

Herb, 0.2–0.3 m tall, erect, well branched, stems shortly sericeous, plants forming clumps. *Leaves*: abaxial surface densely sericeous, adaxially sparsely sericeous becoming glabrous; leaflets oblong to obovate, $20\text{--}35 \times 7\text{--}14$ mm, strongly revolute, apex rounded, apiculate; petiole 5–12 mm long; stipules ovate, $7\text{--}9 \times 4$ mm, base obliquely cordate. *Inflorescence* pseudo-umbellate, 1–3-flowered, peduncle well developed, 25–60 mm long, leaf-opposed; bracts lanceolate, $4\text{--}5 \times 1.5\text{--}2.0$ mm; bracteoles lanceolate, 3×1 mm. *Calyx* shortly sericeous, upper lip 10–11 mm long, sinus 7–9 mm deep; lower lip 11–12 mm long, lobes 3–4 mm long, medial lobe linear. *Corolla* yellow; standard orbicular, $12\text{--}14 \times 9\text{--}12$ mm, adaxial surface sparsely sericeous, base obtuse, claw 3 mm long; wings oblong, $11\text{--}12 \times 3$ mm, with lunate-lamellate sculpturing in upper central zone, claw 3 mm long; keel cymbiform, $9\text{--}10 \times 4$ mm, upper margin shortly ciliate, 3 mm long. *Stamens* monadelphous; an-

thers dimorphic. *Ovary* weakly arcuate, 8–9 mm long, densely sericeous; style 4–5 mm long, basally hairy. *Fruit* compressed, sericeous, $38\text{--}42 \times 5$ mm. *Seed* not seen. Figure 3.

The obvious alliance between this species and *A. lunare* (Meisner 1843; Harvey 1862) contradicts the use of torulose fruits as a sectional character within *Argyrolobium* (Bentham 1844; Harvey 1862). *A. splendens* is known only from the type collection which was gathered on the coastal fold mountains which flank the Kleinrivier at Hermanus (Figure 4). The species is sympatric with its ally *A. lunare* (L.) Druce which is distinguished by its torulose fruits, longer petioles and non-revolute leaf margins.

WESTERN CAPE.—3419 (Caledon): mountainsides around Klein Rivier, (–AD), Krauss 927 (NY, G, MO, W).



FIGURE 3.—*Argyrolobium splendens*, Krauss 927. A, reproductive branches; B, calyx, inner surface; C, wing; D, keel; E, standard. Scale bars: A, 20 mm; B–E, 2 mm.

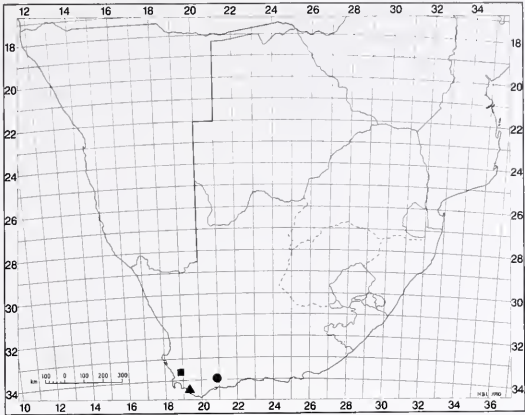


FIGURE 4.—Recorded distribution of: *A. crinitum*, ●; *A. splendens*, ▲; and *A. angustissimum*, ■.

3. *Argyrolobium angustissimum* (E.Mey.) T.J. Edwards comb. nov. Type: Western Cape, Paarlberg, 1000–2000 ft, Drège s.n. (G!, lecto. selected here; BM!, E!, MO!, OXF!, P!, S!, W!, isolecto.).

Chasmone angustissima E.Mey.: 75 (1836).

Herb, 0.2–0.3 m tall, erect, sparsely branched, stems weakly perennial, shortly sericeous, plants solitary, or forming small clumps. *Leaves* adaxially glabrous, abaxially shortly sericeous leaflets; linear, 25–45 × 1.0–1.5 mm, conduplicate, apex acute; petiole 1.5–3.0 mm long; stipules deltoid to linear, 2–4 × 0.5–1.0 mm. *Inflorescence* pseudo-umbellate, 1–6-flowered, peduncles leaf-opposed; bracts linear, 4–5 × 0.75–1.00 mm; bracteoles linear, 3.5–5.0 × 0.75 mm. *Calyx* shortly sericeous, upper lip 14–15 mm long, sinus 12–14 mm deep; lower lip 15–17 mm long, lobes 4–5 mm long, medial lobe linear. *Corolla* russet and yellow; standard obovate, 16–18 × 10–12 mm, adaxial surface sparsely sericeous, base cuneate, claw 1–2 mm long; wings narrowly oblong to obovate, 14.0–15.0 × 3.5 mm, with lunate-lamellate sculpturing in upper basal zone, claw 1.0–1.5 mm long; keel cymbiform, 7–9 × 3.5–5.0 mm, distally sericeous, claw 1.0–5.0 mm. *Stamens* monadelphous; anthers very weakly dimorphic. Ovary weakly arcuate, ± 10 mm long, densely sericeous; style 3–4 mm long, basally hairy. *Fruit* not seen. *Seed* not seen.



FIGURE 5.—*Argyrolobium aciculare*, Stokoe 61544: A, habit. B, *A. harveyanum*, Edwards s.n.: habit of southern form. C–F, L: *A. filiforme*, Walgate 399: C, calyx; D, keel; E, wing; F, standard; L, pistil. G–K, *A. angustissimum*, Drège 1419: G, calyx; H, keel; I, wing; J, standard; K, pistil. Scale bars: A, B, 20 mm; C–L, 2 mm.

A. angustissimum is formally recognised on the basis of its robust habit and large distinctive flowers (Figure 5). It is closely allied to *A. tuberosum* which has similar leaf morphology and flower colour but differs in the size and morphology of the flowers. The species are allopatric, *A. angustissimum* is known from a single Drège collection (Figure 4) made at Paarlberg whereas *A. tuberosum* occurs sporadically in grasslands of the Eastern Cape, KwaZulu-Natal, Mpumalanga and into the highlands of Zimbabwe.

WESTERN CAPE.—3318 (Cape Town): Paarlberg, (–DB), Drège s.n. (BM, E, G, MO, OXF, P, S, W).

ACKNOWLEDGEMENTS

I wish to thank the Curators of the cited herbaria for the loan of herbarium specimens and Kew for the provision of cibachromes of their type material. The referees are thanked for their comments on the manuscript. The Natal University Research Fund is gratefully acknowledged for financial assistance.

CONVOLVULACEAE

NEW RECORDS, NAME CHANGES AND A NEW COMBINATION IN SOUTHERN AFRICA

INTRODUCTION

During the preparation of the Convolvulaceae for the *Flora of southern Africa (FSA)*, Vol. 28, part 1, it became clear that several changes and additions are necessary to the list compiled by Welman: 588–595 (1993). As publication of this part of the *FSA* is not expected in the near future, it will be useful to publish them here.

NEW RECORDS

The following species have recently been recorded as new to southern Africa.

6979000–00200 ***Bonamia velutina* Verdc.** in Kirkia 1: 27, t. III (1961).

Very rare perennial in the Northern Province and in the Ingwavuma area of KwaZulu-Natal; also reported from southeastern Botswana, Zimbabwe and Mozambique.

B. velutina can be confused with *Seddera capensis* (E.Mey. ex Choisy) Hallier f. and *S. suffruticosa* (Schinz) Hallier f., but can be recognized by the greyish velvety pubescence on the upper side of the leaves and the golden brown pubescence on the underside as well as on the calyx lobes.

7003000–01450 ***Ipomoea consimilis* Schulze-Menz** in Notizblatt des Botanischen Gartens und Museums zu Berlin 14: 112 (1938).

Recorded from Tanzania (Lindi District), Mozambique (Sofala) and Maputaland in northern KwaZulu-Natal. The

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T.J. EDWARDS*

* Unit for Plant Growth and Development, Botany Department, University of Natal, P.O. Box 01, Scottsville 3209.
MS. received: 1995-05-25.

South African specimens of this species were previously listed under *I. urbaniana* (Dammer) Hallier f., which does not occur south of the Lindi District in Tanzania (Ross 1972: 296). Distinguished by its climbing, shrubby habit, its yellow villous young parts, its large ovate leaves and its mauve to purple flowers.

7003000–01950 ***Ipomoea fanshawei* Verdc.** in Kirkia 6: 119 (1967).

Fairly rare perennial, endemic to southern Zambia and northeastern Botswana. Distinguished by its rhomboid-lanceolate leaves with entire to lobed margins and its 60 mm long, pale purple or mauve corollas.

7003000–02150 ***Ipomoea fulvicaulis* (Hochst. ex Choisy) Boiss. ex Hallier f.** in Botanische Jahrbücher 18: 128 (1893).

Perennial from Ethiopia, Kenya, Tanzania, Malawi, Zaïre, Zambia and Zimbabwe to Mozambique; also in northern Botswana. Distinguished by its yellow-brown pubescent stems, flowers in small heads and 25–50 mm long purplish corollas. Only var. *fulvicaulis* has been recorded from the *FSA* region; var. *heterocalyx* (Schulze-Menz) Verdc. and var. *asperifolia* (Hallier f.) Verdc. do not reach southern Africa.

7003000–03350 ***Ipomoea ochracea* (Lindl.) G.Don**, A general system of gardening and botany 4: 270 (1837).

Found throughout tropical Africa down to Ngamiland in Botswana, where it is very rare. Only the typical var. is known from the *FSA* region. Var. *curtissii* (House) Stearn,

a much stouter plant, comes from Uganda. The typical variety is distinguished by being a perennial herb with bright yellow flowers with a dark throat, arranged in cymes.

NAME CHANGES

The following name changes have become necessary.

Turbina sensu Meeuse (1957) is sunk into *Ipomoea*, *sens. lat.* at least as far as six of the southern African species are concerned. The only constant difference from *Ipomoea sens. strict.* is the indehiscence of the capsules which is almost certainly attributable to an adaptation associated with seed dispersal. A dehiscent capsule, such as that of *Ipomoea sens. strict.*, releases several diaspores (normally 4), whereas in the African species of *Turbina*, the fruit usually contains only one or two seeds and dehiscence would therefore not add much to the number of diaspores. If there was a tendency towards fleshiness of the fruit wall and endozoochory, dehiscence would not serve a useful purpose. The southern African species formerly placed in *Turbina* form a very heterogeneous assemblage and some of them resemble certain species or species groups of *Ipomoea* much more than the others.

7003000–02450 *Ipomoea holubii* Baker in Kew Bulletin: 72 (1894).

Turbina holubii (Baker) A.Meeuse: 780 (1957).

7003000–03150 *Ipomoea oblongata* E.Mey. ex Choisy in A.P. de Candolle, Prodrum systematis naturalis regni vegetabilis etc.: 368 (1845).

Turbina oblongata (E.Mey. ex Choisy) A.Meeuse: 778 (1957).

I. atherstonei Baker in Baker & C.H.Wright: 53 (1904); A.Meeuse: 741 (1957).

A very common and very variable species. There are no important morphological differences between *I. oblongata* and *I. atherstonei*; there is no geographical or ecological separation either.

7003000–03450 *Ipomoea oenotheroides* (L.f.) Raf. ex Hallier f. in Botanische Jahrbücher 18: 156 (1893) in syn.

Turbina oenotheroides (L.f.) A.Meeuse: 775 (1957).

7003000–04350 *Ipomoea robertsiana* Rendle in Journal of Botany, British and Foreign, London 39: 18 (1901).

Turbina robertsiana (Rendle) A.Meeuse: 777 (1957).

7003000–04850 *Ipomoea stenosphon* Hallier f. in Sitzungsberichte der Akademie der Wissenschaften in Wien 107,1: 50 (1898b).

Turbina stenosphon (Hallier f.) A.Meeuse: 783 (1957).

7003000–04875 *Ipomoea suffruticosa* Burch., Travels in the interior of southern Africa, Vol. 2: 226 (1824).

Turbina suffruticosa (Burch.) A.Meeuse: 776 (1957).

7003020–00100 *Paralepistemon shirensis* (Oliv.) Lejoly & Lisowski, in Bulletin du Jardin botanique national de Belgique, Brussels 56: 197 (1986).

Turbina shirensis (Oliv.) A.Meeuse: 782 (1957).

This monotypic genus differs from *Ipomoea* as follows: *Stamens* inserted on triangular, large ($\pm 2 \times 2$ mm) glandular pilose scales situated near base of corolla tube. *Ovary* with very short beak persistent in fruit. *Style* articulated at base, caducous. *Fruit* indehiscent, more or less woody.

6978000–00150 *Seddera schizantha* Hallier f. in Bulletin de l'Herbier Boissier 6: 532 (1898a).

Bonamia schizantha (Hallier f.) A.Meeuse: 665 (1957).

Metaporana angolensis N.E.Br.: 169 (1914).

When N.E. Brown described *Metaporana*, he included two species, *M. angolensis* and *M. densiflora* (Hallier f.) N.E.Br. These two species are not congeneric and this confused Meeuse (1957) into accepting *Metaporana* for *S. schizantha*, which name Brown had overlooked. The species which Brown re-described as *M. angolensis* is not quite erect but tends to climb, so that Meeuse thought it was a *Bonamia* rather than something else. However, McInt & Ward: 234 (1968) in their monograph of *Bonamia* exclude *B. schizantha* from *Bonamia* and list it as a synonym of *S. schizantha*.

6993000–00250 *Convolvulus aschersonii* Engl., Über die Hochgebirgsflora des tropischen Afrika: 349 (1892).

C. sagittatus Thunb. var. *aschersonii* (Engl.) Verdc.: 345 (1957).

C. aschersonii can be distinguished from *C. sagittatus* by its usually few-flowered inflorescences (flowers usually solitary in the latter), small flowers (8–10 mm long) and different leaf shape (middle lobe up to 60×12 mm, often crenate or sinuate, occasionally dissected; basal lobes often toothed or multifid). These characters do not occur together in *C. sagittatus*.

6993000–00600 *Convolvulus capensis* Burm.f., Prodrum florae capensis: 5 (1768).

C. capensis Burm.f. var. *bowieanus* (Rendle) A.Meeuse: 693 (1957).

C. capensis Burm.f. var. *plicatus* (Desr.) Baker in Baker & C.H.Wright: 78 (1904) as to new combination only, excl. descr., synonyms and specimens cited.

In view of the appreciable variation of the leaf morphology on a single plant the varieties distinguished by Meeuse (1957: 693) are presumably only growth forms. Young shoots may have undissected leaves (before more dissected ones have developed) and depauperate and drought forms may have narrow leaves.

6993000–01300 *Convolvulus natalensis* Bernh. in Flora 27: 829 (1844).

C. natalensis Bernh. var. *transvaalensis* (Schltr.) A.Meeuse: 689 (1957).

There are intermediates between the two varieties distinguished in Meeuse (1957) and their distribution ranges overlap. The differences in leaves and sepals do not warrant the retention of two varieties (which may conceivably belong to a single population).

6993000–01500 *Convolvulus ocellatus* Hook.f. in Curtis's Botanical Magazine 70: t. 4065 (1844).

C. ocellatus Hook.f. var. *ornatus* (Engl.) A.Meeuse: 673 (1957).

This taxon is very variable and the extreme forms have been described as varieties; but there are many transitional specimens, those from the drier areas tending to form more dissected leaves and a denser tomentum.

6993000–02050 *Convolvulus sagittatus* Thunb., Prodrum plantarum capensium 1: 35 (1794).

C. sagittatus Thunb. subsp. *grandiflorus* (Hallier f.) A.Meeuse var. *graminifolius* (Hallier f.) Baker & C.H.Wright ex A.Meeuse: 683 (1957).

C. sagittatus Thunb. subsp. *grandiflorus* (Hallier f.) A.Meeuse var. *grandiflorus*: 683 (1957).

C. sagittatus Thunb. subsp. *grandiflorus* (Hallier f.) A.Meeuse var. *linearifolius* (Hallier f.) Baker & C.H.Wright ex A.Meeuse: 683 (1957).

C. sagittatus Thunb. subsp. *sagittatus* var. *hirtellus* (Hallier f.) A.Meeuse: 682 (1957).

C. sagittatus Thunb. subsp. *sagittatus* var. *namaquensis* A.Meeuse: 682 (1957).

C. sagittatus Thunb. subsp. *sagittatus* var. *phyllosepalus* (Hallier f.) A.Meeuse: 681 (1957).

C. sagittatus Thunb. var. *ulosepalus* (Hallier f.) Verdc.: 346 (1957).

The great range in inflorescences and leaf size and shape has led to the description of numerous subspecies and varieties, but examination of a larger number of specimens shows that these form a continuous range rather than discrete entities.

It is noteworthy that most of the varieties previously described, are not geographically restricted to small areas, but have a wide range. Without extensive field and experimental studies, it is impossible to delimit varieties in this entangled assembly.

7003000–00800 *Ipomoea bathycolpos* Hallier f. in Botanische Jahrbücher 18: 144 (1893).

I. bathycolpos Hallier f. var. *sinuatodentata* Hallier f.: 53 (1899).

Specimens with larger leaves with coarse irregular teeth, a narrow basal sinus and usually larger flowers, were described as the var. *sinuatodentata* Hallier f., but this variety is not worth maintaining, because these specimens which seem to be restricted to the Lydenburg area (with a milder winter climate) may simply represent a more luxuriant form.

7003000–01100 *Ipomoea bolusiana* Schinz in Verhandlungen des Botanischen Vereins der Provinz Brandenburg 30: 271 (1888).

I. bolusiana Schinz var. *pinnatipartita* Verdc.: 118 (1967).

The above variety represents an extreme form of the range of variation of the leaf morphology and does not deserve separate rank.

7003000–02900 *Ipomoea magnusiana* Schinz in Verhandlungen des Botanischen Vereins der Provinz Brandenburg 30: 272 (1888).

I. magnusiana Schinz var. *eenii* (Rendle) A.Meeuse: t. 1201 (1956a).

Two varieties were distinguished in Meeuse: (1957: 742, 743), based mainly on the size of the corolla. It now appears that the var. *eenii* cannot be upheld; the dimensions of the corolla overlap one another and all other features just about agree. The large-flowered specimens are presumably only luxuriant individuals that grew in favourable sites or after heavy rains.

7003000–03300 *Ipomoea obscura* (L.) Ker Gawl. in Botanical Register 3: t. 239 (1817).

I. obscura (L.) Ker Gawl. var. *fragilis* (Choisy) A.Meeuse: t. 1222 (1956b); 747 (1957).

The plants separated as var. *fragilis* differ only in the absence of a dark centre in the throat of the corolla. Such colour variations are caused by a difference in a few genes (or only a single one) and there is no reason to recognize the individuals with a concolorous corolla as more than a forma.

All the specimens from southern Africa belong to the var. *obscura* with corolla concolorous or with a dark centre. The var. *sagittifolia* Verdc. occurs from Zimbabwe to Tanzania.

7003000–01850 *Ipomoea dichroa* Choisy in A.P. de Candolle, Prodrum systematis naturalis regni vegetabilis etc. 9: 364 (1845); Verdc.: 165 (1978).

I. arachnosperma Welw.: 588 (1859); A.Meeuse: 736 (1957).

Verdcourt (1978: 165) states: 'Since there is no bar to the use of the epithet *dichroa* in *Ipomoea* and Choisy provides an adequate description, the correct name for this species would appear to be *Ipomoea dichroa* treating it as a new name dating from Choisy.'

7003000–02475 *Ipomoea indica* (Burm.f.) Merr., An interpretation of Rumphius's Herbarium amboinense: 445 (1917); Austin: 357 (1986).

Convolvulus indicus Burm.f.: 6 (1755).

I. congesta R.Br.: 425 (1810); A.Meeuse: 735 (1957).

Austin (1986: 357) gives the full synonymy of this highly polymorphic species which had been described several times in different genera, from specimens collected in both the western and eastern hemispheres.

6995000–00050 *Hewittia malabarica* (L.) Suresh in Nicolson, Suresh & Manilal, An interpretation of Van Rheedee's Hortus malabaricus: 88 (1988).

Convolvulus malabaricus L.: 155 (1753).

Convolvulus sublobatus L.f.: 135 (1781).

H. sublobata (L.f.) Kuntze: 441 (1891); A.Meeuse: 698 (1957).

This rather variable species is widespread in the Old World and had been described several times from different localities (Gonçalves 1987: 31).

7010000–00050 *Stictocardia laxiflora* (Baker) Hallier f. in Bulletin de l'Herbier Boissier 6: 548 (1898a).

Ipomoea woodii N.E.Br.: 101 (1894).

S. woodii (N.E.Br.) Hallier f.: 548 (1898a); A.Meeuse: 773 (1957).

S. laxiflora (Baker) Hallier f. var. *woodii* (N.E.Br.) Verdc.: 173 (1963b).

In the past, features like the lengths of the peduncles and the pedicels were used to distinguish *S. laxiflora* (Baker) Hallier f. var. *woodii* (N.E.Br.) Verdc. However, the description made by Meeuse (1957: 773) was based on a whole series of herbarium specimens, all from a single plant grown in the Durban Botanical Garden. The range of variation is so broad that such distinctions cannot be made.

NEW COMBINATION

6997010–00100 *Xenostegia tridentata* (L.) Austin & Staples in Brittonia 32: 533 (1980).

subsp. *angustifolia* (Jacq.) A.Meeuse, comb. nov.

Ipomoea angustifolia Jacq.: 367 (1789).

Merremia tridentata (L.) Hallier f. subsp. *angustifolia* (Jacq.) Ooststr. var. *angustifolia* Verdc.: 51 (1963a).

Iconotype: Jacq., Icones plantarum rariorum 2: 10, t. 317 (1786–1793).

The segregation of *Xenostegia* from *Merremia* is based on two characters, namely, the straight anthers at anthesis (in contrast to the always at least somewhat twisted anthers typical of *Merremia*) and the pantoporate pollen grains rather unique in the family. The two genera also have a different 'look'.

EXCLUDED SPECIES

Ipomoea shupangensis Baker

Welman (1993: 594) lists this species for KwaZulu-Natal. However, no authoritatively identified material is known from southern Africa. *I. shupangensis* occurs in tropical Africa as far south as Zimbabwe (Hwange) and Mozambique (Gaza).

I. batatas (L.) Lam. (the 'Sweet Potato' from tropical America), *I. coccinea* L. (annual scarlet-flowered twiner from North America) and *I. fistulosa* Choisy (purple-flowered shrub from tropical America) are also listed in Welman (1993), but occur only as garden escapes or culture relics.

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A.D.J. MEEUSE* AND W.G. WELMAN**

* Voorstraat 41, NL-1931 AH Egmond aan Zee, The Netherlands.

** National Botanical Institute, Private Bag X101, Pretoria 0001.

MS. received: 1995-08-30.

APIACEAE

A NEW SPECIES OF *CENTELLA*

The genus *Centella* is currently under revision. Field work and a study of morphological and genetic variation in the genus, (Schubert & Van Wyk in prep.) led to the discovery of an up to now undescribed species, closely related to *C. macrocarpa*.

***Centella glauca* Schubert & B.-E. van Wyk sp. nov.**, a *Centella macrocarpa* habitu multo robustiore, foliis glaucis foliisque juvenilibus laminaribus non acicularibus differt.

TYPE.—Western Cape, 3219 (Wuppertal): between Matjies River and Dwaars River on road between Ceres and Algeria, *Hugo 730* (STE holo.; PRE). See *Hugo 729* (PRE, STE) which are from functionally male plants collected at the same locality as the bisexual holotype of this andromonoecious species.

Resprouting, densely virgate, robust, mostly dioecious perennial (Figure 6), up to 700 mm tall. *Leaves* acicular, somewhat succulent, (50–)80–90(–130) × 1–2 mm; distinctly glaucous, concolorous; glabrous; acicular; lamina indistinguishable from petiole; main vein slightly sunken; margin entire; apex acute (Figure 7D, E); coppice leaves petiolate; petiole (30–)40–50(–100) mm long; lamina cuneate or narrowly elliptic, (7–)15–25 × 2–3 mm (Figure 7A–C); base cuneate; margins sometimes inrolled, with 1–3 acute teeth on upper third of lamina; apex acute. *Inflorescence* mostly sparse, borne along the shoots; functionally male inflorescence with 3–6 umbellules; rays (5–)10–15(–25) mm long; bracts 2, acute at apex, glabrous; male flowers 3 on each umbellule, petals cream-coloured, glabrous; functionally bisexual inflorescence with single umbellule; ray (2–)15–20(–35) mm long; bracts 2, acute at apex, 2–3 × 1 mm, shorter than fruit (Figure 7I–L). *Fruit* very large, (4–)5(–7) × (3–)4(–5) mm; widely elliptic in commissural view, with 2 prominent, purple ribs visible on either side of both carpels (Figure 7J, J).

Judged by morphological similarities, the closest relative of *C. glauca* is *C. macrocarpa*, even though specimens have mostly been identified as *C. linifolia* or *C. virgata* in the past. *Centella glauca* is similar to *C. macrocarpa* but differs in the much larger habit, the glaucous leaves (hence the specific epithet) and the laminate, often toothed, coppice leaves. The mature leaves of *C. glauca* are acicular. Another distinct feature of *C. glauca* is that the rays of the functionally male and female umbellules

may often be extremely long. The ribbed fruits are very similar in shape and surface sculpturing (Figure 7I, J, N) to those of *C. macrocarpa*, but are usually much larger.

Centella glauca is furthermore geographically isolated from *C. macrocarpa* and is restricted to the extreme northern area of the Western Cape (Figure 8). It occurs on the Witzenberg, northwards along the Grootwinterhoek Mountains and also further north in the Cederberg near Citrusdal and Clanwilliam.

This new species forms an interesting morphological link between *C. linifolia* and the *C. macrocarpa/virgata*

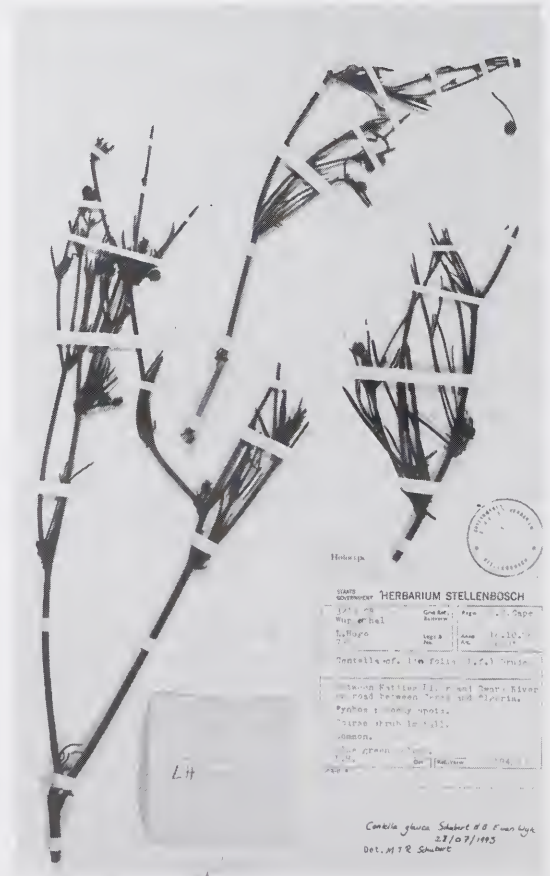


FIGURE 6.—Holotype of *Centella glauca*, Hugo 730.



FIGURE 7.—*Centella glauca*. A, adaxial view of tridentate coppice leaf; B, abaxial view of coppice leaf with one/two teeth; C, adaxial view of coppice leaf with in-rolled margins; D, adaxial view of acicular mature leaf; E, abaxial view of acicular mature leaf; F, functionally male umbellule with 3 flowers; G, male inflorescence with 3 umbellules; H, female inflorescence (infructescence) reduced to a single fruit; I, mature fruit with bracts; J, fruit with bracts removed; K, abaxial view of bract; L, adaxial view of bract; M, habit; N, cross section of fruit. Scale bars: A–E, G, H, J & L, M, 5 mm; F & I, 10 mm; N, 2 mm.

complex. The apparent isolation of *C. linifolia* from the series *Virgatae* Adamson (1951) is therefore reduced. The new species combines the glaucous leaf surface and distinct lamina of *C. linifolia* (at least in coppice shoots) with the acicular leaves and virgate habit of *C. macrocarpa*. The new species appears to be invariably resprouting, whereas *C. virgata* and some populations of *C. macrocarpa* are obligate reseeder. Further studies are in pro-

gress to examine relationships amongst these and related species.

Material examined

WESTERN CAPE.—3219 (Wuppertal): Heuning Vlei, (–AA), Esterhuysen 7464 (BOL); Sneeuwkop, (–AC); Eselbank, (–AC), Taylor

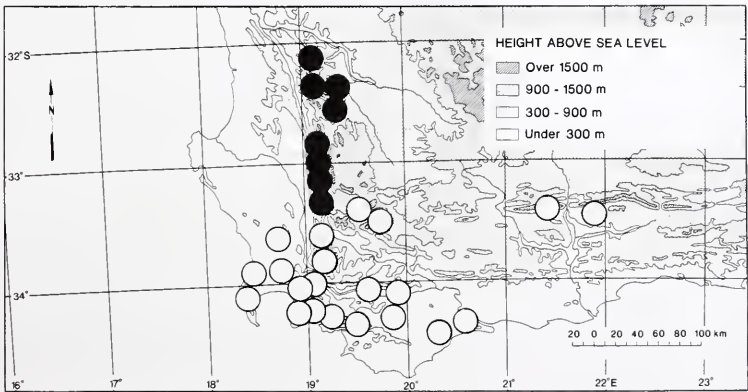


FIGURE 8.—The known geographic distribution of *Centella glauca*, ●, and *Centella macrocarpa*, ○.

11357 (NBG); Cederberg, Matjies River, (–AD), *Wagener* 261 (NBG); Wolfberg, (–AD), *Esterhuysen* 18099 (BOL); Truitjieskraal, (–AD), *Stirton & Zantovska* 11496 (NBG); Zoo Ridge, (–AD), *Taylor* 6117 (STE); between Matjies River and Dwars River, (–CB), *Hugo* 729, 730 (PRE, STE); Kromme River, (–CB), *Leighton* 21610 (BOL); Dasklip Pass, (–CC), *Schubert & Van Wyk* 101 (E, GRA, JRAU, KMG, MO, NBG, PRE, S, WIND); mountains above Porterville, (–CC), *Barker* 249 (BOL); *Edwards* 16149 (BOL); *Esterhuysen* 16116 (BOL, NBG, PRE); *Thompson* 1459 (PRE, STE), 1460 (STE); *Zeyher* 727 (SAM). 3319 (Worcester): De Tronk, (–AA), *Low* 899 (STE); Visgat, (–AA), *Stokoe s.n.* (SAM); Groothoek Peak, (–AA), *Campbell* 10362 (PRE, STE); Groot Winterhoek, (–AA), *Phillips* 1751 (SAM); Winterhoek, (–AA), *Bolus* 5057 (BOL); Witzenberg, (–AC), *Andreae* 187 (STE). Without precise locality: *Marloth s.n.* (PRE); *Zeyher* 727 (GRA, SAM), 742 (GRA).

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M.T.R. SCHUBERT* and B.-E. VAN WYK*

* Department of Botany, Rand Afrikaans University, P.O. Box 524, Auckland Park 2006, Johannesburg.
MS. received: 1995-09-20.

Cytogenetic studies in some representatives of the subfamily Pooideae (Poaceae) in South Africa. 1. The tribe Aveneae, subtribe Aveninae

J.J. SPIES*, S.K. SPIES*, S.M.C. VAN WYK*, A.F. MALAN* and E.J.L. LIEBENBERG**

Keywords: Aveneae, chromosomes, meiosis, Poaceae, polyploidy, Pooideae

ABSTRACT

This is a report on chromosome numbers for 14 species of the subtribe Aveninae, which is largely naturalized in South Africa. This is the first chromosome number report for *Helictotrichon longifolium* (Nees) Schweick. (n = 14), *H. longum* (Stapf) Schweick. (n = 14), *H. namaquensis* Schweick. (n = 14) and *Lophochloa cristata* (L.) Hyl. (n = 7, 21/2, 14). The subtribe has a basic chromosome number of seven, and fewer ploidy levels occur in the naturalized species in South Africa than in the same species in other parts of the world. All tetraploid specimens were allopolyploids.

INTRODUCTION

Polyploidy is one of the most important forms of chromosomal evolution in plants (Stebbins 1971). Preliminary studies on chromosome numbers of South African grasses revealed over 80% polyploid specimens (Moffett & Hurcombe 1949; De Wet 1954; De Wet & Anderson 1956; Pienaar 1955; De Wet 1960; Davidse *et al.* 1986; Spies & Du Plessis 1986a & b, 1987a & b; Spies & Jonker 1987; Du Plessis & Spies 1988; Spies & Du Plessis 1988; Spies & Voges 1988; Spies *et al.* 1989, 1990, 1991, 1992; Du Plessis & Spies 1992; Strydom & Spies 1994; Visser & Spies 1994a–c). The present article corroborates these findings.

The Pooideae is, for the largest part, introduced to southern Africa. The majority of species belonging to this subfamily is restricted to either the winter rainfall area of South Africa or to high altitude areas. The tribe Aveneae Dumort. comprises 57 genera and approximately 1 050 species in the world (Clayton & Renvoize 1986). Most South African representatives (18 genera and 59 species) are naturalized (Gibbs Russell *et al.* 1990). Clayton & Renvoize (1986) subdivided the tribe into four subtribes, i.e. Duthieinae Potztl, Aveninae Presl, Phalaridinae Rchb. and Alopecurinae Dumort. The genera representing these subtribes are listed in Table 1.

The aim of this study is to determine the chromosome numbers, polyploid levels and meiotic chromosome behaviour of the South African representatives of the tribe Aveninae. These results will eventually be compared with results of indigenous and endemic taxa to compare the frequency of polyploidy between indigenous and introduced grasses.

MATERIALS AND METHODS

Cytogenetic material was collected in two different ways for the purpose of this study. The material was either

collected and fixed in the field, or living material was collected in the field and transplanted in the nurseries of either the National Botanical Institute (Pretoria) or the Department of Botany and Genetics, University of the Orange Free State (Bloemfontein), where cytogenetic material was collected and fixed. The material used and their localities are listed in Table 2. Voucher specimens are housed in the Geo Potts Herbarium, Department of Botany and Genetics, University of the Orange Free State, Bloemfontein (BLFU) or the National Herbarium, Pretoria (PRE).

Young inflorescences were fixed in Carnoy's fixative (Carnoy 1886). The fixative was replaced by 70% ethanol after 24–48 hours of fixation. Anthers were squashed in 2% aceto-carmine (Darlington & LaCour 1976). Slides were made permanent by freezing them with liquid CO₂ (Bowen 1956), followed by dehydration in ethanol and mounting in Euparal. An Olympus Vanox-S or Nikon Microphot photomicroscope and Ilford Pan-F film (ASA 50) were used for the photomicrographs. At least ten cells

TABLE 1.—List of subdivisions of the tribe Aveneae, indicating the genera and number of species present in southern Africa

| Subtribe | Genus | No. of species |
|----------------------|---------------------------------|----------------|
| Alopecurinae Dumort. | <i>Agrostis</i> L. | 11 |
| | <i>Ammophila</i> Host | 1 |
| | <i>Calamagrostis</i> Adans. | 1 |
| | <i>Gastridium</i> P.Beauv. | 1 |
| | <i>Lagurus</i> L. | 1 |
| | <i>Polypogon</i> Desf. | 4 |
| Aveninae Presl | <i>Aira</i> L. | 2 |
| | <i>Arrhenatherum</i> P.Beauv. | 1 |
| | <i>Avena</i> L. | 5 |
| | <i>Corynephorus</i> P.Beauv. | 1 |
| | <i>Deschampsia</i> P.Beauv. | 2 |
| | <i>Helictotrichon</i> Schult. | 12 |
| | <i>Holcus</i> L. | 2 |
| | <i>Koeleria</i> Pers. | 1 |
| | <i>Lophochloa</i> Rchb. | 2 |
| Phalaridinae Rchb. | <i>Periballia</i> Trin. | 1 |
| | | |
| Duthieinae Potztl | Not represented in South Africa | |
| Phalaridinae Rchb. | <i>Anthoxanthum</i> L. | 5 |
| | <i>Phalaris</i> L. | 6 |

* Department of Botany and Genetics, University of the Orange Free State, P.O. Box 339, Bloemfontein 9300.
** National Botanical Institute, Private Bag X101, Pretoria 0001.
MS. received: 1995-10-25.

TABLE 2.—Haploid chromosome numbers of representatives of the subtribe Aveninae (Poaceae, Pooideae, Aveneae) in southern Africa with the voucher specimen numbers and their specific localities, arranged according to the system of Edwards & Leistner (1971)

| Taxon | Voucher | n | Locality |
|--|------------------------|---------|--|
| <i>Aira caryophylllea</i> L. | <i>Spies</i> 3438 | 7 | WESTERN CAPE.—3418 (Simonstown): Silvermine Nature Reserve, (–AB) |
| <i>A. cupaniana</i> Guss. | <i>Spies</i> 3797,4950 | 7 | WESTERN CAPE.—3118 (Vanrhynsdorp): Gifberg, (–DC) |
| | <i>Spies</i> 4964 | 7 | NORTHERN CAPE.—3119 (Calvinia): 5 km from Nieuwoudtville to Clanwilliam, (–CA) |
| | <i>Spies</i> 4597 | 7 | WESTERN CAPE.—3319 (Worcester): Du Toit's Kloof Pass, (–AC) |
| | <i>Spies</i> 4623 | 7 | WESTERN CAPE.—3420 (Bredasdorp): 3 km north of De Hoop Nature Reserve, (–AD) |
| | <i>Spies</i> 3464 | 7 | WESTERN CAPE.—3420 (Bredasdorp): 8 km from Ouplaas to De Hoop Nature Reserve, (–AD) |
| | <i>Spies</i> 4643 | 7 | WESTERN CAPE.—3420 (Bredasdorp): 4 km north of De Hoop Nature Reserve, (–AD) |
| <i>Avena barbata</i> Brot. | <i>Spies</i> 4837 | 14 | (ORANGE) FREE STATE.—2827 (Senekal): 6 km from Nebo to Fouriesburg via Generaalsnek, (–DB) |
| | <i>Spies</i> 4808 | 14 | (ORANGE) FREE STATE.—2827 (Senekal): 25 km from Clocolan to Ficksburg, (–DC) |
| | <i>Spies</i> 5302 | 14 | NORTHERN CAPE.—3119 (Calvinia): 7 km from Nieuwoudtville to Clanwilliam, (–CA) |
| | <i>Spies</i> 5287 | 14 | NORTHERN CAPE.—3119 (Calvinia): 56 km from Calvinia to Nieuwoudtville, (–CC) |
| <i>A. byzanthina</i> K.Koch. | <i>Spies</i> 2481 | 21 | EASTERN CAPE.—3127 (Lady Frere): 24 km from Dordrecht to Lady Grey, (–AA) |
| <i>A. fatua</i> L. | <i>Spies</i> 4899 | 21 | NORTHERN CAPE.—2917 (Springbok): 14 km from Springbok to Hondeklipbaai, (–DB) |
| | <i>Spies</i> 4915 | 21 | NORTHERN CAPE.—3017 (Hondeklipbaai): 88 km from Springbok to Kamieskroon via Soebatsfontein, (–BA) |
| <i>Corynephorus fasciculatus</i> Boiss. & Reut. | <i>Spies</i> 3690 | 7 | WESTERN CAPE.—3218 (Clanwilliam): 11 km from Piquetberg in Versveld Pass, (–DC) |
| <i>Helictotrichon longifolium</i> (Nees) Schweick. | <i>Spies</i> 3982 | 14 | EASTERN CAPE.—3127 (Lady Frere): 9 km from Dordrecht to Barkly East, (–AC) |
| <i>H. longum</i> (Stapf) Schweick. | <i>Spies</i> 3428 | 14 | WESTERN CAPE.—3218 (Clanwilliam): Roche Nature Reserve, (–AB) |
| <i>H. namaquense</i> Schweick. | <i>Spies</i> 3137 | 14 | NORTHERN CAPE.—3220 (Sutherland): 10 km from Sutherland to Matjiesfontein, (–BC) |
| <i>H. turgidulum</i> (Stapf) Schweick. | <i>Saayman</i> 75 | 14 | MPUMALANGA (EASTERN TRANSVAAL).—2430 (Pilgrim's Rest): 14 km from Sabie to Graskop, (–DD) |
| | <i>Saayman</i> 102 | 14 | MPUMALANGA (EASTERN TRANSVAAL).—2530 (Lydenburg): 39 km from Lydenburg to Roosenekal, (–AA) |
| | <i>Spies</i> 5103 | 14 | MPUMALANGA (EASTERN TRANSVAAL).—2630 (Carolina): 46 km from Ermelo to Breyten, (–AA) |
| | <i>Spies</i> 5097 | 28 | MPUMALANGA (EASTERN TRANSVAAL).—2630 (Carolina): 9 km from Ermelo to Breyten, (–AC) |
| | <i>Spies</i> 2355 | 14 | MPUMALANGA (EASTERN TRANSVAAL).—2730 (Vryheid): near Piet Retief, (–BB) |
| | <i>Spies</i> 2654 | 14+0–2B | SWAZILAND.—2631 (Mbabane): 16 km from Mbabane to Oshoek, (–AC) |
| | <i>Spies</i> 4775 | 21 | (ORANGE) FREE STATE.—2926 (Bloemfontein): 19 km from Dewetsdorp to Hobhouse, (–DB) |
| | <i>Spies</i> 4776 | 14 | (ORANGE) FREE STATE.—2926 (Bloemfontein): 19 km from Dewetsdorp to Hobhouse, (–DB) |
| | <i>Spies</i> 4763 | 14 | EASTERN CAPE.—3027 (Lady Grey): 82 km from Barkly East to Lady Grey via Joubert's Pass, (–CB) |
| | <i>Spies</i> 4753 | 14 | EASTERN CAPE.—3027 (Lady Grey): 47 km from Barkly East to Lady Grey via Joubert's Pass, (–CD) |
| | <i>Spies</i> 4721 | 14 | EASTERN CAPE.—3027 (Lady Grey): 34 km from Rhodes to Lundean's Neck, (–DD) |
| | <i>Spies</i> 4678 | 14 | EASTERN CAPE.—3028 (Matatiele): 12 km from Rhodes to Naude's Neck, (–CC) |
| | <i>Spies</i> 2476 | 14 | EASTERN CAPE.—3126 (Queenstown): Penhoek Pass, (–BC) |
| | <i>Davidse</i> 34079 | 14 | WESTERN CAPE.—3420 (Bredasdorp): De Hoop Nature Reserve, (–AD) |
| | <i>Spies</i> 4507 | 14+0–4B | WESTERN CAPE.—3420 (Bredasdorp): 1 km north of De Hoop Nature Reserve, (–CA) |
| | <i>Davidse</i> 33456 | 14 | WESTERN CAPE.—3218 (Clanwilliam): Rocher Nature Reserve, (–AB) |
| <i>Holcus lanatus</i> L. | <i>Saayman</i> 124 | 7+0–1B | MPUMALANGA (EASTERN TRANSVAAL).—2530 (Lydenburg): 27 km from Dullstroom to Belfast, (–CA) |
| | <i>Spies</i> 4675 | 7+1B | EASTERN CAPE.—3028 (Matatiele): 12 km from Rhodes to Naude's Pass, (–CC) |
| <i>Koeleria capensis</i> (Steud.) Nees | <i>Spies</i> 5119 | 7 | MPUMALANGA (EASTERN TRANSVAAL).—2530 (Lydenburg): 11 km from Dullstroom to Lydenburg via Frischgewaagd, (–AC) |
| | <i>Spies</i> 5094 | 7 | MPUMALANGA (EASTERN TRANSVAAL).—2630 (Carolina): 9 km from Ermelo to Breyten, (–AC) |
| | <i>Spies</i> 5102 | 7 | MPUMALANGA (EASTERN TRANSVAAL).—2630 (Carolina): 46 km from Ermelo to Breyten, (–AA) |
| | <i>Spies</i> 4749 | 7 | EASTERN CAPE.—3027 (Lady Grey): 31 km from Barkly East to Lady Grey, (–CD) |
| | <i>Spies</i> 4716 | 7 | EASTERN CAPE.—3128 (Umtata): 38 km from Maclear to Elliot, (–AC) |
| | <i>Spies</i> 3250 | 14 | WESTERN CAPE.—3420 (Bredasdorp): 6 km north of De Hoop Nature Reserve, (–CA) |
| | <i>Spies</i> 4855 | 14 | WESTERN CAPE.—3420 (Bredasdorp): 3 km from De Hoop turnoff to Ouplaas on road between Bredasdorp and Malgas, (–CA) |

TABLE 2.—Haploid chromosome numbers of representatives of the subtribe Aveninae (Poaceae, Pooideae, Aveneae) in southern Africa with the voucher specimen numbers and their specific localities (arranged according to the system of Edwards & Leistner (1971) (continued)

| Taxon | Voucher | n | Locality |
|---|----------------|------|--|
| <i>Lophochloa cristata</i> (L.) Hyl. | Spies 4965 | 21/2 | NORTHERN CAPE.—3119 (Calvinia): 5 km from Nieuwoudtville to Clanwilliam, (–CA) |
| | Spies 4365 | 7 | WESTERN CAPE.—3119 (Calvinia): 55 km from Nieuwoudtville to Clanwilliam, (–CC) |
| | Spies 4567 | 14 | WESTERN CAPE.—3318 (Cape Town): 7 km from Yzerfontein to Darling, (–AC) |
| | Spies 3855 | 14 | WESTERN CAPE.—3319 (Worcester): Mitchell’s Pass, (–AD) |
| | Spies 4499 | 14 | WESTERN CAPE.—3420 (Bredasdorp): 1 km north of De Hoop Nature Reserve, (–CA) |
| <i>L. pumila</i> (Desf.) Bor | Spies 3424 | 7 | WESTERN CAPE.—3218 (Clanwilliam): 5 km south of Eland’s Bay, (–AB) |
| | Spies 3143 | 7 | NORTHERN CAPE.—3219 (Wuppertal): in Hartnekskloof, (–DC) |
| | Davidse 33272a | 7 | NORTHERN CAPE.—2917 (Springbok): 36 km SE of Port Nolloth on road to Kleinsee, (–AC) |
| | | 7 | |

per specimen were studied for each meiotic stage, except where otherwise indicated.

Meiotic chromosome counts are given as haploid (n) numbers to conform to the style set out by the editors of the Index to plant chromosome numbers series, published by the Missouri Botanical Garden.

RESULTS

All studied specimens of *Aira* L. were diploid (Table 2) and all meiotic cells appear normal. Seven bivalents were present during diakinesis (Figure 1A).

Two different ploidy levels, based on seven, were present in the *Avena* L. specimens studied. The species cor-

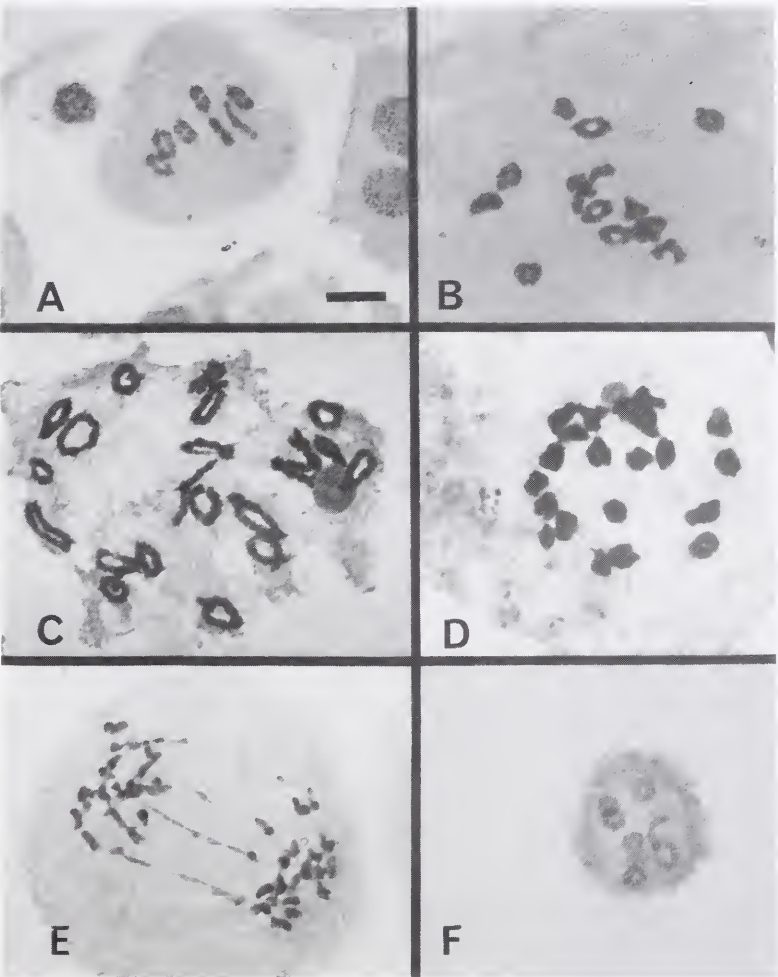


FIGURE 1.—Photomicrographs of meiotic chromosomes in some representatives of the genera *Aira*, *Avena* and *Corynephorus*. A, *Aira cupaniana*, Spies 4597, early metaphase I with 7 Π ; B, *Avena barbata*, Spies 5287, early metaphase I with 14 Π ; C, *A. byzanthina*, Spies 2481, diplotene with 21 Π ; D, *A. fatua*, Spies 4899, diakinesis with 21 Π ; E; *A. fatua*, Spies 4915, anaphase I with chromatid bridges; F, *Corynephorus fasciculatus*, Spies 3690, diakinesis with 7 Π . Scale bar: A & F, 35 μ m; B, D & E, 30 μ m; C, 28 μ m.

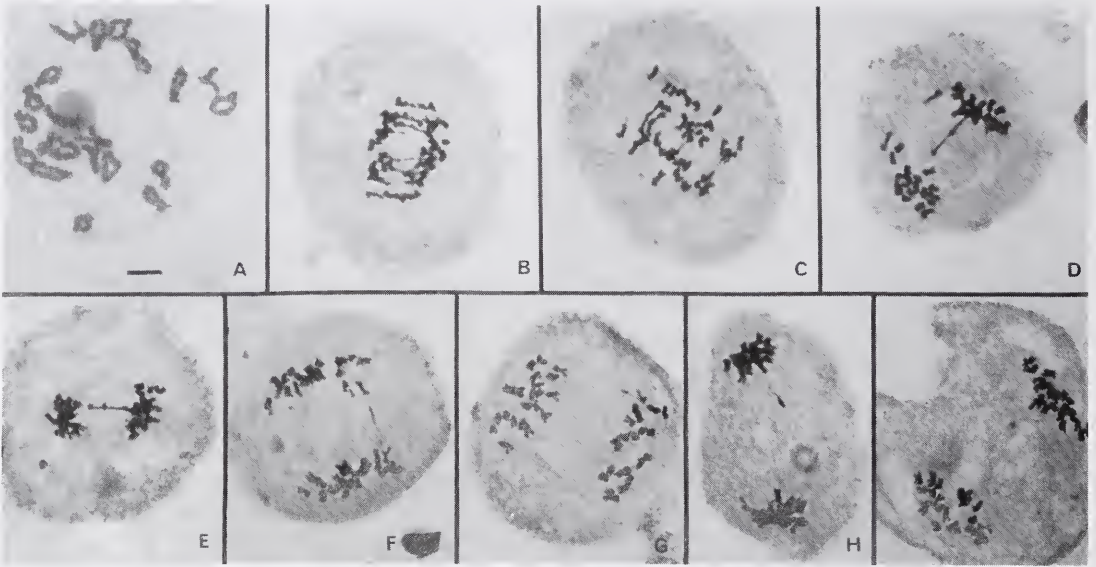


FIGURE 2.—Photomicrographs of meiotic chromosomes in *Avena fatua*, *Spies 4915*. A, diakinesis, with 21II; B–I, anaphases with various numbers of chromatid bridges. Scale bar: A–I, 10 μ m.

responded morphologically and separation of species was sometimes doubtful. According to the classification we received for our specimens, *A. barbata* Pott ex Link is tetraploid (Figure 1B), whereas *A. byzantina* K.Koch (Figure 1C) and *A. fatua* L. (Figure 1D; 2A) are hexaploid. The majority of bivalents were ring bivalents and no multivalents were present. Up to four chromatid bridges per cell have been observed in the three *Avena* species mentioned in *Spies 2481*, 4808, 4899 and 4915) (Figure 1E; 2). The frequent occurrence of this

phenomenon suggests that this specimen is heterozygotic for a high number of paracentric inversions.

The only *Corynephorus fasciculatus* Boiss. & Reut. specimen studied, proved to be a diploid (Figure 1F), with normal meiosis.

Haploid chromosome numbers in the genus *Helictotrichon* ranged from diploid to octaploid (Figure 3A–E). A similar range was observed in *H. turgidulum*. The

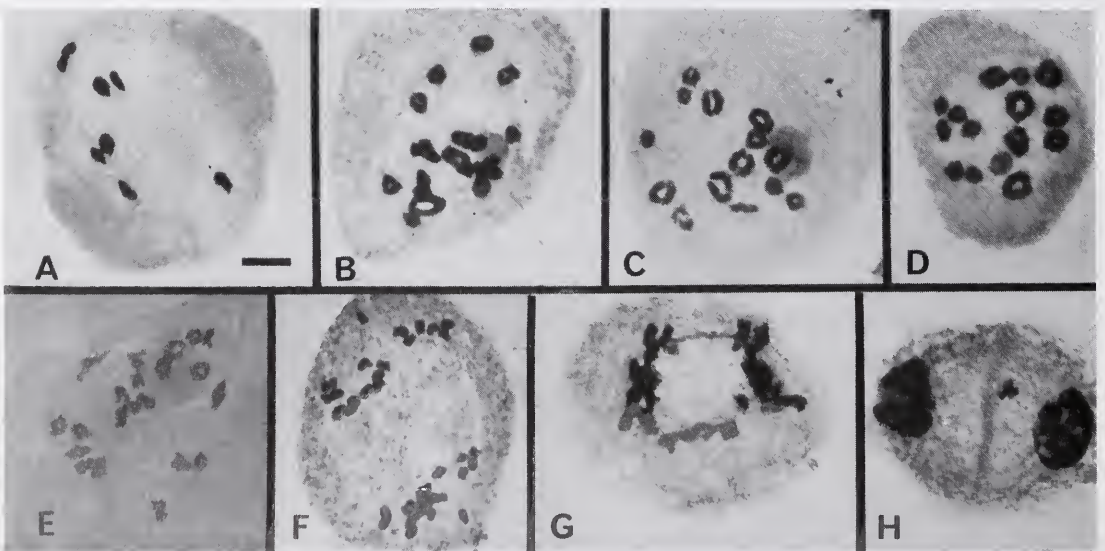


FIGURE 3.—Photomicrographs of meiotic chromosomes in some representatives of *Helictotrichon turgidulum*. A, *Spies 4721*, diakinesis with 7II; B, *Spies 4763*, diakinesis with 14II; C, *Spies 4678*, diakinesis with 14II; D, *Spies 2355*, diakinesis with 14II; E, *Spies 4775*, diakinesis with 21II; F, *Spies 4507*, anaphase with 16-16 segregation of chromosomes, thus indicating the presence of B-chromosomes; G, *Spies 3137*, anaphase I with a chromatid bridge and a chromosome bridge; H, *Spies 3137*, telophase I with a micronucleus. Scale bar: 30 μ m.

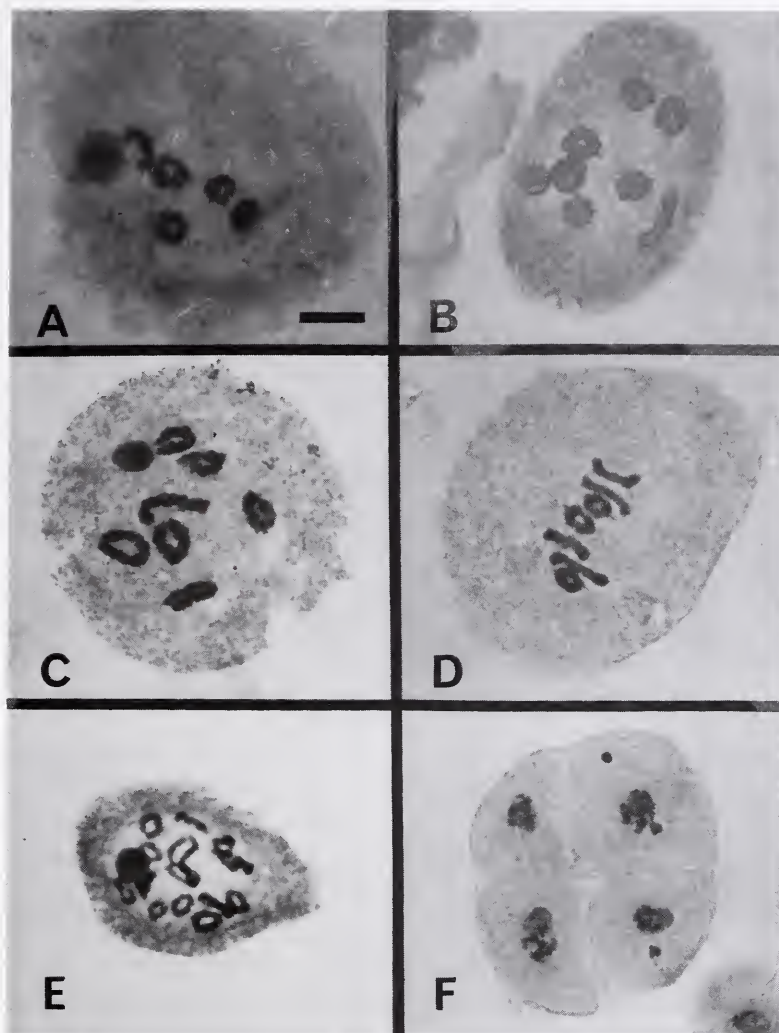


FIGURE 4.—Photomicrographs of meiotic chromosomes in some representatives of the genera *Holcus* and *Koeleria*. A, *Holcus lanatus*, Saayman 124, diakinesis with 7II; B, *Koeleria capensis*, Spies 5119, diakinesis with 7II; C, *K. capensis*, Spies 5094, diakinesis with 7II; D, *K. capensis*, Spies 5119, metaphase I with 7II; E, *K. capensis*, Spies 4855, diakinesis with 14II; F, *K. capensis*, Spies 5111, telophase II with two micronuclei. Scale bar: A–D, 30 μ m; E & F, 27 μ m.

other species were all tetraploid. All the tetraploid specimens were allopolyploids, with the observed chromosome configurations concurring best with the expected configurations for the 2:2 model of Kimber & Alonso (1981). All specimens had x -values of 1. The 2:2 model indicates the presence of two sets of genomes, both consisting of two genomes. The x -value can vary from 0.5 (relative distance between the sets of genomes equals the relative distance between the genomes within a set) to 1 (relative distance between sets much larger than the distance within a set). The x -value of one, therefore, indicates that the specimens are allopolyploid. Two specimens had B-chromosomes (0–4B) (Figure 3F). Chromosomes were regarded as B-chromosomes if additional chromosomes were observed in some cells of an individual, or if the behaviour of the additional chromosomes deviated from the expected behaviour of euchromosomes. Occasionally meiotic abnormalities of euchromosomes during anaphase I have been observed. These abnormalities included chromatid bridges (Figure 3G), anaphase laggards and micronuclei during telophase I (Figure 3H).

Holcus lanatus was diploid (Figure 4A), with regular chromosome behaviour. *Koeleria capensis* encompassed both diploid and tetraploid specimens (Figure 4B–E). Occasionally chromosome laggards during anaphase I and micronuclei during telophases I and/or II (Figure 4F) have been observed. *Lophochloa pumila* was diploid (Figure 5A), whereas *L. cristata* varied from diploid to tetraploid (Figure 5B–G). One *L. cristata* specimen was either triploid or it contained up to seven B-chromosomes (Figure 5F, G; 6).

DISCUSSION

Aira is naturalized in South Africa and two species are recognized in this country, i.e. *A. caryophyllaea* and *A. cupaniana* (Gibbs Russell *et al.* 1990). Both species are diploid, $n = x = 7$ (Table 2), with normal meiosis. This deviates from the somatic chromosome number of 28 usually reported for *A. caryophyllaea* (Albers & Albers 1973; Queiros 1974; Albers 1978; 1980; Kirschner *et al.* 1982). However, a diploid specimen has been reported by Romero Zarco (1988). This study confirms the chromo-

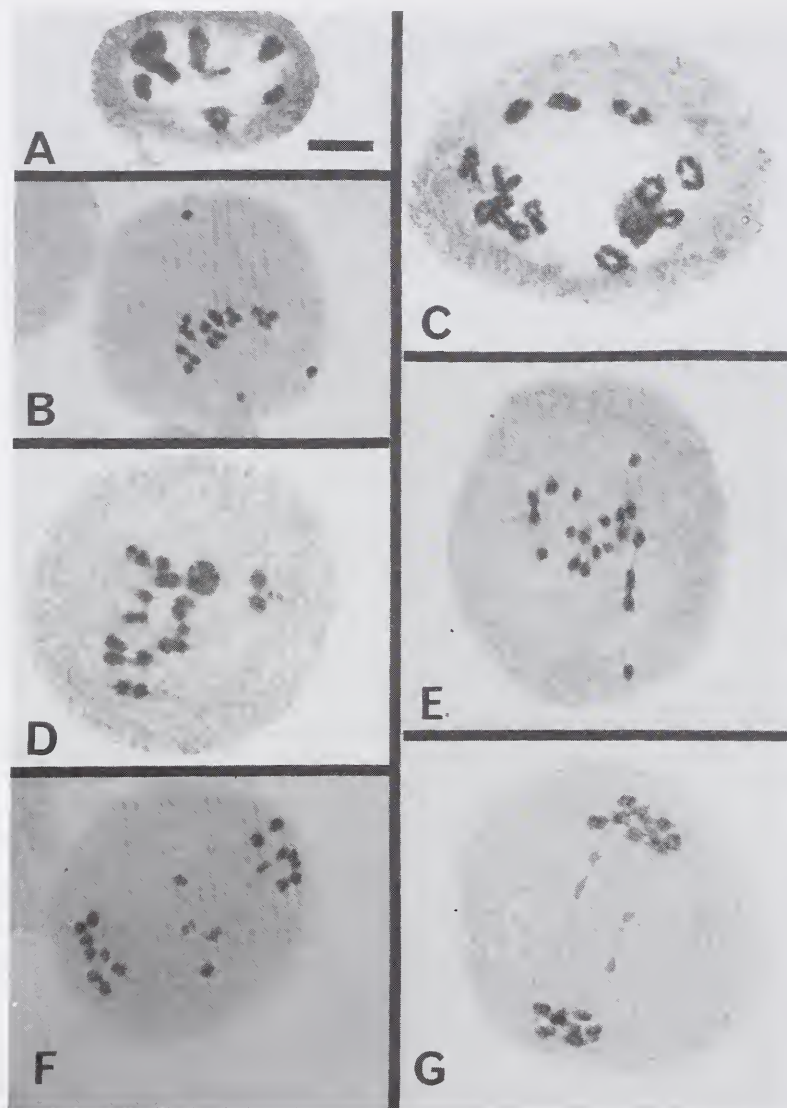


FIGURE 5.—Photomicrographs of meiotic chromosomes in some representatives of the genus *Lophochloa*. A, *Lophochloa pumila*, Davidse 33272, diakinesis with 7 Π ; B, *L. cristata*, Spies 4965, metaphase I with 7 Π 7 Π ; C, *L. cristata*, Spies 4567, diakinesis with 14 Π ; D, *L. cristata*, Spies 4965, metaphase I; E, *L. cristata*, Spies 4965, early anaphase I; F, *L. cristata*, Spies 4965, late anaphase I with 4 laggards; G, *L. cristata*, Spies 4965, late anaphase I with laggards. Scale bar: A, C–G, 30 μ m; B, 27 μ m.

some numbers previously described for *A. cupaniana* (Albers & Albers 1973; Albers 1980). Although polyploidy is frequently observed in Europe, it seems absent in the naturalized species.

Arrhenatherum P.Beauv. is represented by one naturalized species in South Africa, *A. elatius* (L.) Presl (Gibbs Russell *et al.* 1990). No specimen could be obtained for this study. However, published results indicate that diploid ($n = 7$ or $2n = 14$), tetraploid ($n = 14$ or $2n = 28$) and hexaploid ($n = 28$) specimens of *A. elatius* have been observed elsewhere (Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991).

Avena consists of four naturalized and a cultivated species in South Africa (Gibbs Russell *et al.* 1990). All *A. barbata* specimens studied, are tetraploid. This supports the different ploidy levels, ranging from diploid to hexaploid, previously described (Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991). These results

may indicate that a single introduction, or several introductions from the same ploidy level, of *A. barbata*, occurred.

Avena byzantina is hexaploid, thus supporting the chromosome number previously described (Morikawa 1982). The high frequency of ring bivalents and the absence of any multivalent suggests an allopolyploid origin for both species. This allopolyploid origin is confirmed by the corresponding values obtained during this study and when the expected chromosome associations for the 2:2 model of Kimber & Alonso (1981) is determined. The x-value of 1 indicates no relationship between the chromosomes of the two different genomes.

The hexaploid chromosome number determined for *A. fatua* supports the published chromosome number of this species (Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991). The absence of multivalents in the studied specimens, suggests an allopolyploid origin for this species.

The naturalized *Corynophoris fasciculatus* is the only representative of this genus in South Africa (Gibbs Russell *et al.* 1990). Our study confirmed the diploid chromosome number previously described for this species (Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991).

Deschampsia P.Beauv. is represented by two naturalized species in South Africa, *D. caespitosa* (L.) P.Beauv. and *D. flexuosa* (L.) Trin. (Gibbs Russell *et al.* 1990). In Europe *D. caespitosa* has haploid chromosome numbers of 9, 12, 13 and 26 (Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991), whereas *D. flexuosa* has haploid chromosome numbers of 7 and 14 (Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991). It would be very interesting to study the South African species cytogenetically to determine whether we have both basic chromosome numbers of 7 and 13 present, as suggested by chromosome numbers of other members of this genus.

Helictotrichon is represented by 13 indigenous species in South Africa (Gibbs Russell *et al.* 1990). Four species were included in this study, *H. longifolium*, *H. longum*, *H. namaquensis* and *H. turgidulum*. This is, to the best of our knowledge, the first report of chromosome numbers for *H. longifolium*, *H. longum* and *H. namaquensis*, which are all tetraploid. Additionally to the tetraploid chromosome number described for *H. turgidulum* (Hoshino & Davidse 1988), diploid, hexaploid and octaploid specimens were studied. All tetraploid specimens (from the four species) conform with the expected chromosome configurations for the 2:2 model of Kimber & Alonso (1981). The x-values of 1 indicate allopolyploid origins for all these specimens.

Holcus is represented by one indigenous species, *H. setiger* Nees, and a naturalized species, *H. lanatus* (Gibbs Russell *et al.* 1990). Only the latter species has been studied and the species seems to be diploid in South Africa, in contrast to the diploid and tetraploid species described in other countries (Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991).

Koeleria capensis is indigenous and the only representative of the genus *Koeleria* in South Africa (Gibbs Russell *et al.* 1990). This study revealed two ploidy levels for this species, diploid and tetraploid, thus confirming previous results (Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991). The tetraploid specimens were restricted to the southern Cape, near Bredasdorp. Their chromosome configurations concurred with the expected configurations for the 2:2 model with an x-value of 1. These specimens are consequently allopolyploids.

Lophochloa is represented by two naturalized species in South Africa, *L. cristata* and *L. pumila* (Desf.) Bor (Gibbs Russell *et al.* 1990). This is, to the best of our knowledge, the first report on chromosome numbers for *L. cristata*, which has at least two different ploidy levels, diploid and tetraploid. One specimen (Spies 4965) with abnormal chromosomal behaviour was observed. This specimen is either a triploid or it contains up to seven B-chromosomes. The additional chromosomes do not differ morphologically from the 'normal' chromosomes. However, since the number of additional chromosomes seems to differ from one cell to another (Figure 6), we suggest that they are B-chromosomes. The chromosome configurations harmonized best with the expected values obtained from the 2:2 model of Kimber & Alonso (1981). An x-value of 1 indicated that the tetraploid specimens

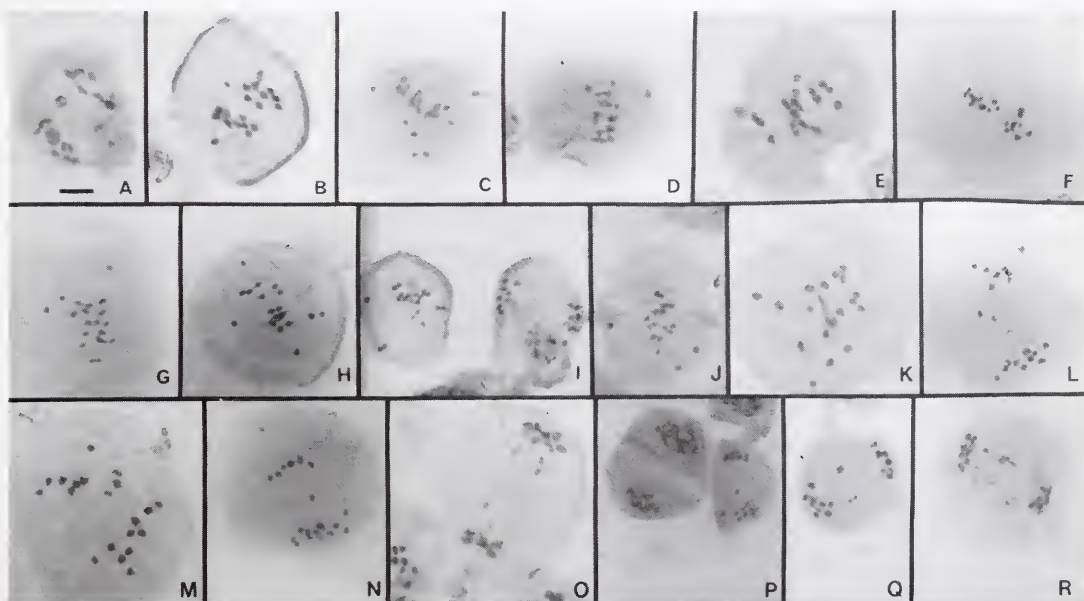


FIGURE 6.—Photomicrographs of meiotic chromosomes in *Lophochloa cristata*, Spies 4965. A–R, various cells indicating the difficulty to determine whether the additional chromosomes are B-chromosomes or whether they represent a third genome. Scale bar: A–R, 10 μ m.

are allopolyploids. This study confirms the diploid status already described for *L. pumila* (Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991). However, we found no confirmation for a basic chromosome number of 13 for *Lophochloa* as often reported (Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991).

The genus *Periballia* Trin. comprises a single naturalized species in South Africa, *P. minuta* (L.) Asch. & Graebn. (Gibbs Russell *et al.* 1990). Reports indicate that this species has a haploid chromosome number of 4 (Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991).

The subtribe Aveninae is largely naturalized in South Africa. The exceptions are the genus *Helictotrichon* and the species *Holcus setiger* and *Koeleria capensis*. The subtribe has a basic chromosome number of seven, and less ploidy levels occur in the naturalized species in South Africa in comparison to the same species in other parts of the world. This may be attributed to the introduction of these species. The species deviating from the basic chromosome number of the subtribe need to be investigated thoroughly.

ACKNOWLEDGEMENTS

Dr Gerrit Davidse (Missouri Botanical Garden, St Louis, Missouri, USA) is thanked for some material used during this study. Financial support from the Foundation for Research Development and the University of the Orange Free State, is gratefully acknowledged.

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Cytogenetic studies in some representatives of the subfamily Pooideae (Poaceae) in South Africa. 2. The tribe Aveneae, subtribes Phalaridinae and Alopecurinae

J.J. SPIES*, S.K. SPIES*, S.M.C. VAN WYK*, A.F. MALAN*† and E.J.L. LIEBENBERG**

Keywords: Aveneae, chromosomes, meiosis, Poaceae, polyploidy, Pooideae

ABSTRACT

This is a report on chromosome numbers for the subtribes Phalaridinae and Alopecurinae (tribe Aveneae) which are, to a large extent, naturalized in South Africa. Chromosome numbers of 34 specimens, representing nine species and four genera, are presented. These numbers include the first report on *Agrostis avenacea* Gmel. ($n = 4x = 28$). New ploidy levels are reported for *Phalaris aquatica* L. ($n = x = 7$), *Agrostis barbuligera* Stapf var. *barbuligera* ($n = 2x = 14$ and $n = 4x = 28$) and *A. lachnantha* Nees var. *lachnantha* ($n = 3x = 21$).

INTRODUCTION

The first paper in this series on chromosome numbers of representatives of the tribe Aveneae in South Africa, indicated the importance of determining the ploidy levels and basic chromosome numbers of naturalized and endemic flora in South Africa (Spies *et al.* 1996). This second paper in the series is restricted to the subtribes Phalaridinae and Alopecurinae.

The subtribe Phalaridinae Rchb. consists of three genera (Clayton & Renvoize 1986), of which two are represented in South Africa, i.e. *Anthoxanthum* L. and *Phalaris* L. (Gibbs Russell *et al.* 1990). The subtribe Alopecurinae Dumort. consists of 27 genera (Clayton & Renvoize 1986), with only six being represented in South Africa (Gibbs Russell *et al.* 1990), i.e. *Agrostis* L., *Ammophila* Host, *Calamagrostis* Adans., *Gastridium* P.Beauv., *Lagurus* L. and *Polypogon* Desf. (Gibbs Russell *et al.* 1990).

The aim of this study was to determine the chromosome numbers, polyploid levels and meiotic chromosome behaviour of the South African representatives of the tribe Aveninae. These results will eventually be compared with results of indigenous and endemic taxa to compare the frequency of polyploidy between indigenous and introduced grasses.

MATERIALS AND METHODS

The material was either collected and fixed in the field, or living material was collected in the field and planted in the nurseries of either the Department of Botany and Genetics, University of the Orange Free State (Bloemfontein), or the National Botanical Institute (Pretoria), where the cytogenetic material was collected and fixed. The ma-

terial used and the collecting localities are listed in Table 1. Voucher specimens are housed in the Geo Potts Herbarium, Department of Botany and Genetics, University of the Orange Free State, Bloemfontein (BLFU) or the National Herbarium, Pretoria (PRE).

Anthers were squashed in aceto-carmin and meiotically analysed (Spies *et al.* 1996). Chromosome numbers are presented as haploid chromosome numbers to conform to previous papers on chromosome numbers in this journal (Spies & Du Plessis 1986). These numbers were compared with results published in the chromosome atlases of Fedorov (1969), Ornduff (1967–1969), Moore (1970–1972, 1974, 1977), Goldblatt (1981, 1983, 1985, 1988) and Goldblatt & Johnson (1990, 1991, 1994). Genome homology was determined in some tetraploid specimens according to the models described by Kimber & Alonso (1981).

RESULTS AND DISCUSSION

The subtribe Phalaridinae Rchb. consists of three genera, of which two are represented in South Africa (Clayton & Renvoize 1986). The genus *Anthoxanthum* consists of 18 species, four of which are endemic to South Africa [*A. brevifolium* Stapf, *A. dregeanum* (Nees) Stapf, *A. ecklonii* (Nees ex Trin.) Stapf & *A. tongo* (Trin.) Stapf] and a fifth species, *A. odoratum* L., which is naturalized (Gibbs Russell *et al.* 1990). The genus *Phalaris* L. comprises 15 species, of which six are naturalized in this country [*P. angusta* Nees ex Trin., *P. aquatica* L., *P. arundinacea* L., *P. canariensis* L., *P. minor* Retz. and *P. paradoxa* L.] (Gibbs Russell *et al.* 1990). No *Phalaris* species is indigenous to South Africa (Gibbs Russell *et al.* 1990).

Apparently only one specimen of the genus *Anthoxanthum* has so far been cytogenetically studied and reported in South Africa, namely of *A. tongo* (Trin.) Stapf for which a haploid chromosome number of $20 + 0-5B$ has been established by one of our laboratories (Spies & Voges 1988). Reports of haploid chromosome numbers of $n = 5$ and 10 from other parts of the world are frequent but numbers such as $n = 20, 35$ or 45 are rarely reported

*Department of Botany and Genetics, University of the Orange Free State, P.O. Box 339, Bloemfontein 9300.

**National Botanical Institute, Private Bag X101, Pretoria 0001.

†Current address: Small Grain Centre, Private Bag X29, Bethlehem 9600. MS. received: 1995-11-09.

TABLE 1.—Haploid chromosome numbers of representatives of the subtribes Phalaridinae, Alopecurinae (Poaceae, Pooideae, Aveneae) in southern Africa, with their voucher specimen numbers and specific localities [arranged according to the system of Edwards & Leistner (1971)]

| Taxon | Voucher | n = | Locality |
|---|----------------------|------|--|
| Subtribe Phalaridinae Rchb. | | | |
| <i>Phalaris aquatica</i> L. | <i>Spies 3676</i> | 7&14 | WESTERN CAPE.—3318 (Cape Town): 5 km from Riebeeek-Kasteel to Malmesbury in Bothmaskloof Pass, (–BD) |
| <i>P. minor</i> Retz. | <i>Davidse 33237</i> | 14 | NORTHERN CAPE.—2917 (Springbok): 6 km from Springbok to Kleinsee, (–DB) |
| | <i>Davidse 33272</i> | 7 | NORTHERN CAPE.—2917 (Springbok): 6 km from Springbok to Kleinsee, (–DB) |
| | <i>Spies 4284</i> | 14 | NORTHERN CAPE.—2917 (Springbok): 17 km from Springbok to Hondeklipbaai, (–DB) |
| | <i>Spies 4880</i> | 14 | NORTHERN CAPE.—2917 (Springbok): 20 km from Springbok to Kleinsee, (–DB) |
| | <i>Spies 3108</i> | 14 | WESTERN CAPE.—3118 (Vanrhynsdorp): Gifberg, (–DC) |
| | <i>Spies 4566</i> | 14 | WESTERN CAPE.—3318 (Cape Town): 7 km from Yzerfontein to Darling, (–AC) |
| | <i>Spies 4572</i> | 14 | WESTERN CAPE.—3318 (Cape Town): 5 km from Langebaan to Langebaanweg, (–DC) |
| | <i>Spies 5306</i> | 14 | NORTHERN CAPE.—3119 (Calvinia): 10 km from Nieuwoudtville to Clanwilliam, (–AC) |
| | <i>Spies 4978</i> | 14 | NORTHERN CAPE.—3119 (Calvinia): 88 km from Nieuwoudtville to Clanwilliam in Botterkloof, (–CC) |
| | <i>Spies 4593</i> | 14 | WESTERN CAPE.—3320 (Montagu): 22 km from Villiersdorp to Worcester via Koppies, (–AD) |
| <i>P. paradoxa</i> L. | <i>Spies 4509</i> | 14 | WESTERN CAPE.—3420 (Bredasdorp): 1 km north of De Hoop Nature Reserve, (–CA) |
| | <i>Spies 5395</i> | 7 | WESTERN CAPE.—3319 (Worcester): 11 km from Ceres in Mitchell's Pass, (–AD) |
| Subtribe Alopecurinae Dumort. | | | |
| <i>Agrostis avenacea</i> Gmel. | <i>Saayman 78</i> | 28 | MPUMALANGA (EASTERN TRANSVAAL).—2430 (Pilgrim's Rest): 10 km from Graskop to Bosbokrand, (–DD) |
| | <i>Spies 3922</i> | 28 | WESTERN CAPE.—3319 (Worcester): McGregor FM Tower, (–DB) |
| | <i>Spies 3522</i> | 28 | WESTERN CAPE.—3323 (Willowmore): Spitskop, in Prince Alfred Pass on road between Knysna and Uniondale, (–CC) |
| <i>A. barbuligera</i> Stapf var. <i>barbuligera</i> | <i>Saayman 88</i> | 28 | MPUMALANGA (EASTERN TRANSVAAL).—2430 (Pilgrim's Rest): 2 km from Graskop to Pilgrim's Rest, (–DD) |
| | <i>Saayman 57</i> | 14 | MPUMALANGA (EASTERN TRANSVAAL).—2530 (Lydenburg): 23 km from Lydenburg to Sabie, (–BA) |
| | <i>Spies 2467</i> | 14 | EASTERN CAPE.—3126 (Queenstown): Penhoek Pass, (–BC) |
| <i>A. lachnantha</i> Ness var. <i>lachnantha</i> | <i>Saayman 89</i> | 28 | MPUMALANGA (EASTERN TRANSVAAL).—2430 (Pilgrim's Rest): 2 km from Graskop to Pilgrim's Rest, (–DD) |
| | <i>Saayman 76</i> | 28 | MPUMALANGA (EASTERN TRANSVAAL).—2430 (Pilgrim's Rest): 14 km from Graskop to Sabie, (–DD) |
| | <i>Spies 2662</i> | 21 | (ORANGE) FREE STATE.—2826 (Brandfort): Glen Agricultural College, (–CD) |
| | <i>Spies 2504</i> | 21 | EASTERN CAPE.—3027 (Lady Grey): near Barkly East, (–DC) |
| | <i>Spies 4726</i> | 21 | EASTERN CAPE.—3027 (Lady Grey): 49 km from Rhodes to Lundean's Nek, (–DD) |
| | <i>Spies 2467</i> | 21 | EASTERN CAPE.—3126 (Queenstown): Penhoek Pass, (–BC) |
| <i>Lagurus ovatus</i> L. | <i>Davidse 33570</i> | 7 | EASTERN CAPE.—3325 (Port Elizabeth): King Neptune Beach, (–DC) |
| | <i>Spies 5227</i> | 7 | EASTERN CAPE.—3325 (Port Elizabeth): Greenacres, (–DC) |
| | <i>Spies 3894</i> | 7 | WESTERN CAPE.—3418 (Simonstown): Silvermine Nature Reserve, (–AD) |
| <i>Polypogon monspeliensis</i> (L.) Desf. | <i>Spies 2895</i> | 7 | NAMIBIA.—2617 (Bethanie): Fish River Bridge on road to Lüderitz, (–DD) |
| | <i>Spies 2945</i> | 14 | NORTHERN CAPE.—2816 (Oranjemund): on riverbank at crossing of Orange River (Dreigratdrif), (–BB) |
| | <i>Spies 3083a</i> | 14 | WESTERN CAPE.—3118 (Vanrhynsdorp): Gifberg Pass, (–DC) |
| | <i>Spies 5199</i> | 14 | EASTERN CAPE.—3324 (Steytlerville): 34 km from Patensie to Willowmore, (–CB) |
| <i>P. viridis</i> (Gouan) Breistr. | <i>Spies 2912</i> | 14 | NAMIBIA.—2615 (Lüderitz): in Lüderitz, (–CB) |
| | <i>Spies 5201</i> | 14 | EASTERN CAPE.—3324 (Steytlerville): 34 km from Patensie to Willowmore, (–CB) |

(Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1991, 1994). In addition to these numbers based on $x = 5$, three reports of $n = 28$ for *A. borii*, therefore $x = 7$, have been published (Goldblatt 1981, 1985, 1988). With only three reports suggesting a basic chromosome number of seven rather than the five indicated in 55 other reports, we suggest that the basic chromosome number of the genus *Anthoxanthum* is five, as our research indicates. However, a re-investigation of this genus will help to clarify the position of *A. borii* in the genus.

Three species of the genus *Phalaris* were included in this study (Table 1). The only specimen of *P. aquatica* investigated, had both diploid ($n = x = 7$) and tetraploid ($n = 2x = 14$) chromosome numbers (Figure 1A, B). We attribute this apparent discrepancy to cell fusion (Spies & Van Wyk 1995). This process involves the formation of polynucleate microspores after cell fusion and the consequent formation of polyhaploid pollen. This phenomenon is frequently observed in grasses and was discussed by Spies & Van Wyk (1995). *Phalaris aquatica* was represented by a diploid specimen ($n = x = 7$) in this study. This is a lower chromosome number than the tetraploid one previously described (Moore 1971; Goldblatt 1983, 1988). Meiosis was normal at both ploidy levels with only bivalents observed.

One specimen of *P. minor* was diploid (Figure 1C, D) and the rest (10 specimens) tetraploid (Figure 1F-H). With the exception of an anaphase I bridge in one cell of one specimen, meiosis was normal and only bivalents were observed in the *P. minor* specimens. *Phalaris minor* specimens proved to be either diploid ($n = x = 7$) or tetraploid ($n = 2x = 14$) in this study, confirming the tetraploid level previously described (Moore 1971; Goldblatt 1983, 1985; Goldblatt & Johnson 1990). In a previous study by one of our laboratories a hexaploid specimen ($n = 3x = 21$) was observed (Spies & Voges 1988). In addition to these

ploidy levels octoploid specimens ($n = 4x = 28$) have also been described in the literature (Moore 1977). The presence of diploid and possibly allotetraploid specimens in the same species, should render a morphological study of this species worthwhile.

The only *P. paradoxa* specimen studied proved to be a diploid ($n = x = 7$) with normal meiosis, thus supporting previous reports on this species (Moore 1971, 1977; Goldblatt 1981, 1983). A few species of *Phalaris* with a basic chromosome number of six have been reported (Fedorov 1969; Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1994). However, in South Africa all species studied had a basic chromosome number of seven.

The subtribe Alopecurinae Dumort. consists of 27 genera (Clayton & Renvoize 1986), with only six being represented in South Africa (Gibbs Russell *et al.* 1990). *Agrostis* L. consists of 220 species worldwide (Clayton & Renvoize 1986), eight of which are indigenous to South Africa [*A. barbuligera* Stapf, *A. bergiana* Trin., *A. continuata* Stapf, *A. eriantha* Hack., *A. lachnantha* Nees, *A. polypogonoides* Stapf, *A. schlechteri* Rendle and *A. subulifolia* Stapf] and three species are naturalized [*A. avenacea* Gmel., *A. gigantea* Roth and *A. montevidensis* Spreng. ex Nees] (Gibbs Russell *et al.* 1990). Twelve specimens, representing three species of the genus *Agrostis*, were included in this study (Table 1). The three *A. avenacea* specimens were octoploid ($n = 4x = 28$) (Figure 2A, B). This seems to be the first chromosome number report for this species. Two *A. barbuligera* var. *barbuligera* specimens were tetraploid (Figure 2D) and one octoploid. Both ploidy levels differ from the previously described hexaploid ($n = 3x = 21$) level from one of our laboratories (Spies & Du Plessis 1986). Four hexaploid specimens were observed in *A. lachnantha* var. *lachnantha*, as well as two octoploid specimens (Figure 2E, F). The octoploid specimens conform with the number pre-

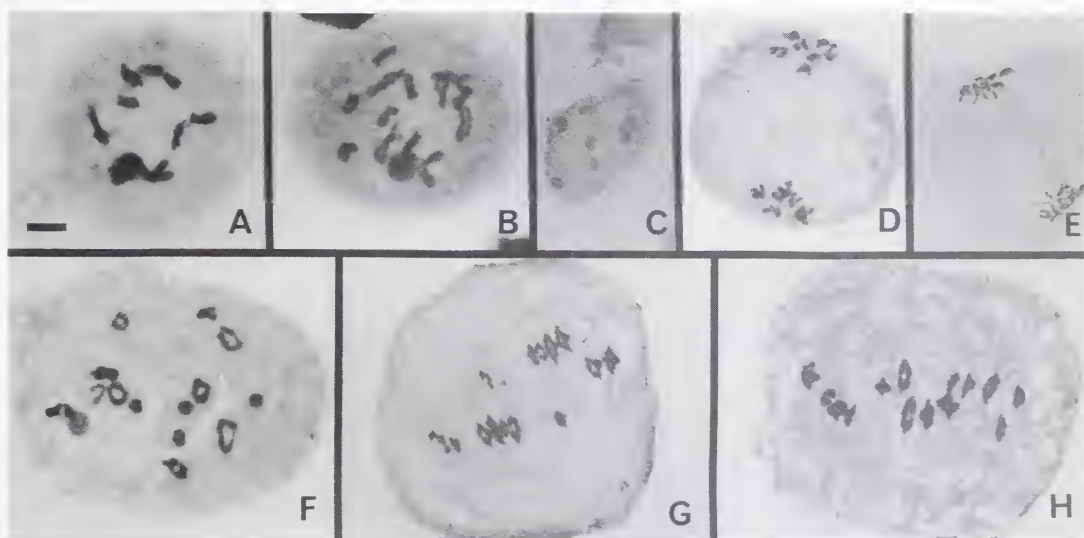


FIGURE 1.—Photomicrographs of meiotic chromosomes in the genus *Phalaris*. A, B, *P. aquatica*, Spies 3676, diplotene/diakinesis with 7II and 14II respectively; C, *P. minor*, Davidse 33272, diakinesis with 7II; D, *P. paradoxa*, Spies 5395, anaphase I with 7 chromosomes in each pole; E, *P. minor*, Spies 4593, late anaphase I with a chromatid bridge; F, *P. minor*, Spies 4284, diakinesis with 14II; G, *P. minor*, Spies 4978, metaphase I with 14II; H, *P. minor*, Davidse 33237, metaphase I with 14II. Scale bar: 10 μ m.

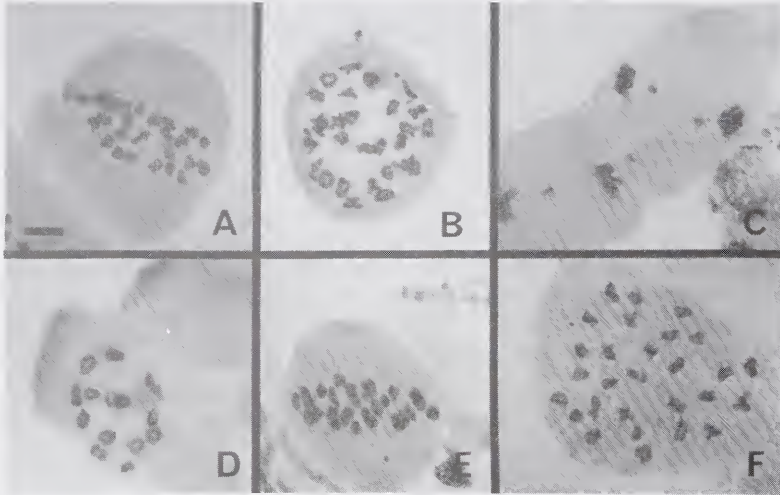


FIGURE 2.—Photomicrographs of meiotic chromosomes in the genus *Agrostis*. A, *A. avenacea*, Saayman 78, early metaphase I with 28 \uparrow ; B, *A. avenacea*, Spies 3522, diakinesis with 28 \uparrow ; C, D, *A. barbuligera* subsp. *barbuligera*, Saayman 57; C, telophase I cells with micronuclei; D, diakinesis with 14 \uparrow ; E, F, *A. lachnantha* subsp. *lachnantha*; E, Saayman 89, metaphase I with 28 \uparrow ; F, Saayman 89, diakinesis with 28 \uparrow . Scale bar: 10 μ m.

viously described by us (Spies & Du Plessis 1986). Meiosis was normal in almost all specimens, excepting one telophase II cell of *A. barbuligera*, where micronuclei were observed (Figure 2C).

Ammophila Host is a north temperate genus with two species, with *A. arenaria* (L.) Link naturalized in South Africa (Gibbs Russell *et al.* 1990). Although this species was not represented in this study, all reports indicate that representatives from the rest of the world are tetraploid $2n = 4x = 28$ (Ornduff 1967; Moore 1970, 1972, 1977; Goldblatt 1983; Goldblatt & Johnson 1994).

Calamagrostis Adans. is a very large genus with ± 270 species (Clayton & Renvoize 1986) with only one species represented in South Africa, *C. epigeios* (L.) Roth (Gibbs Russell *et al.* 1990). Chromosome number reports indicate the presence of tetraploid to octoploid specimens for this

species (Moore 1977; Goldblatt 1981, 1983, 1985, 1988; Goldblatt & Johnson 1990, 1994).

Gastridium phleoides (Nees & Meyen) C.E.Hubb. is the only species of *Gastridium* P.Beauv. introduced to South Africa (Gibbs Russell *et al.* 1990). The only chromosome number report found for this species, indicates $2n = 4x = 28$ (Goldblatt 1981).

The monotypic genus *Lagurus* L. was also introduced to South Africa (Gibbs Russell *et al.* 1990). All *L. ovatus* specimens studied were diploid (Figure 3) with normal meiosis in most cells, excepting a bivalent lying away from the metaphase plate in one cell (Figure 3D) and a laggard in a late anaphase II cell (Figure 3E). The diploid chromosome number observed during this study supports previous reports (Moore 1970, 1972, 1977; Goldblatt 1981, 1983; Goldblatt & Johnson 1994).

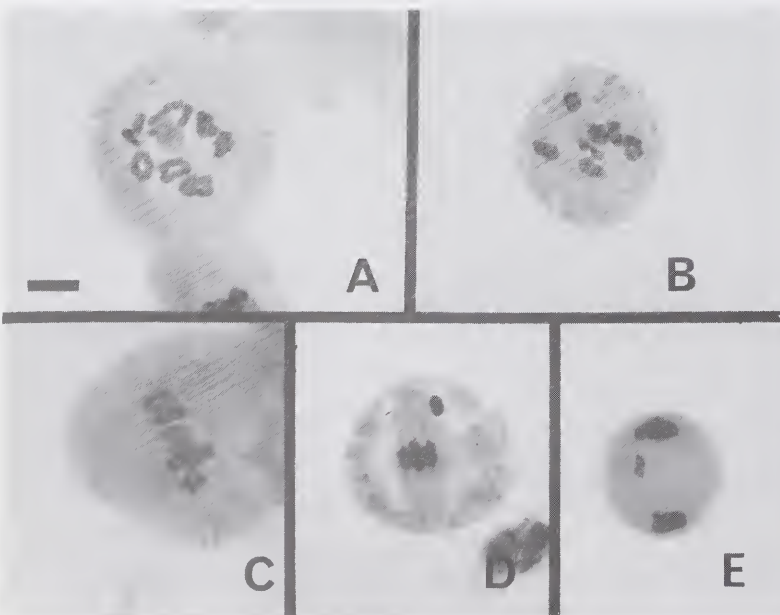


FIGURE 3.—Photomicrographs of meiotic chromosomes in *Lagurus ovatus*. A, Spies 3894, diakinesis with 7 \uparrow ; B, Davidse 33570, diakinesis with 7 \uparrow ; C, Spies 5227, metaphase I with 7 \uparrow ; D, Davidse 33570, metaphase I with one bivalent away from the metaphase plate; E, Spies 3894, telophase I with a laggard. Scale bar: 10 μ m.

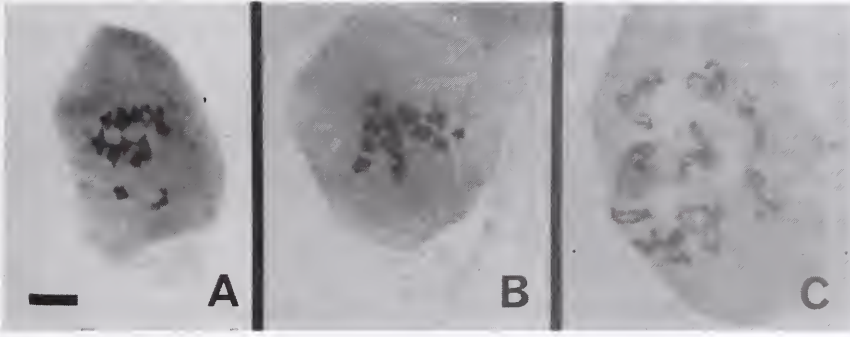


FIGURE 4.—Photomicrographs of meiotic chromosomes in the genus *Polypogon*. A, *P. monspeliensis*, Spies 5199, early metaphase I with 14n; B, *P. monspeliensis*, Spies 3083, early metaphase I with 14n; C, *P. viridis*, Spies 5201, diplotene with 14n. Scale bar: 10 μ m.

The last genus of the Alopecurinae represented in this country is *Polypogon* Desf. This genus comprises 18 species worldwide and is represented by two naturalized [*P. monspeliensis* (L.) Desf. and *P. viridis* (Gouan) Breistr.] and two indigenous [*P. griquensis* (Stapf) Gibbs Russ. and *P. strictus* Nees] species in South Africa (Gibbs Russell *et al.* 1990). Two species of *Polypogon* were studied (Table 1). Three specimens of *P. monspeliensis* were tetraploid (Figure 4A, B), whereas a single specimen was found to be diploid. This confirms previous reports on this species in which diploid to hexaploid specimens have been described (Moore 1970–1972, 1974, 1977; Goldblatt 1981, 1983, 1985; Goldblatt & Johnson 1990, 1994). Both *P. viridis* specimens studied were tetraploid (Figure 4C), thus confirming previous reports (Goldblatt & Johnson 1990, 1994). Meiosis was normal and only bivalents were formed in all specimens.

The two genera representing the subtribe Phalaridineae appear to have two different basic chromosome numbers, i.e. *Anthoxanthum* with five and *Phalaris* with both six and seven. A thorough phylogenetic study based on molecular data of this subtribe could be very useful in determining the evolutionary significance of the change in chromosome number. A basic chromosome number of seven is present in all the genera of the subtribe Alopecurinae present in South Africa.

ACKNOWLEDGEMENTS

The University of the Orange Free State and the Foundation for Research and Development are thanked for financial assistance during this study.

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A tribute to Frank White (5th March 1927 to 12th September 1994)

A. ANGUS* and J.D. CHAPMAN**

Apologia

We are grateful for this opportunity to express our appreciation of our mutual friend Frank White (Figure 1). Angus worked with him early in his career from 1950 and Chapman was associated with him from the early 1960s. We all met for the first time at Chisenga resthouse at the foot of the Mafinga Mts in Malawi in 1952. White and Angus were on an Expedition from Oxford University, and Chapman, of the Nyasaland Forest Dept, was on 'ulendo' with his wife, returning with bulging plant presses from a boundary survey of the Misuku Forests. It was a momentous meeting for Chapman. He learned that all his future collections would be named by Frank himself at Oxford, and it was the beginning of an association that has been the inspiration of Chapman's work ever since. We have all been friends from that day, and often enjoyed each other's hospitality. Thus we feel qualified to write about Frank White while we fondly remember him.

Introduction

Frank White, eminent Oxford botanist and leading authority on African plants and vegetation died in September 1994 after a long struggle with emphysema. Already in 1981 he was beginning to have difficulty with his breathing, yet despite his increasingly debilitating and depressive illness he never let up on his work and was productive to the end, even laying plans for the furtherance of his unfinished projects.

Although his name is now identified with Africa, he did, because of his Cambridge training, go on his first expedition to Arctic Lapland, which resulted in a significant paper in the *Journal of Ecology* (Coombe & White 1951), and a radio broadcast talk about the Lapps entitled 'Europe's last nomadic race' (White 1951a). Thereafter he turned his attentions to Africa. Towards the end of his life, sadly too late, he had begun to widen his interests to include tropical America and the Far East.

Career in brief

Born in Sunderland, County Durham, and educated at the Bede Collegiate School, he won a Scholarship to Cambridge in 1945. There he obtained Firsts in Parts 1 and 2 of the Natural Science Tripos, and won the Frank Smartt Prize in Botany. In 1948 he was appointed Demonstrator in Forest Botany at the Imperial Forestry Institute; was promoted to University lecturer in 1955; became Curator of the Forest Herbarium (FHO) in 1961 and also of the

Fielding-Druce Herbarium (OXF) in 1971. In 1988–89 he was awarded the E. de Wildeman Prize of the Société Botanique de Belgique for his work on the African Ebenaceae, and in 1991 the degree of Sc. D. from Cambridge University in recognition of his published work. In 1992 the Oxford University Dept of Plant Sciences conferred on him the title of Distinguished Research Curator for his 'outstanding research work notably on the taxonomy and ecology of African plants'.

His work

White was one of a line of Oxford botanists interested in Africa, beginning with J. Burt Davy, who founded the Forest Herbarium, and including A.C. Hoyle and J.P.M. Brenan. Burt Davy, incidentally, also founded the herbarium of the Department of Agriculture of the Transvaal Province in Pretoria in 1903 which grew into the National Herbarium, now part of the National Botanical Institute of South Africa. White first became known for his works on the Ebenaceae,



FIGURE 1.—Frank White, 1927–1994.

* 'Rosebank', Boarhills, St Andrews Fife KY16 8PR, Scotland, UK.

** 'Braeriach', Ullar Rd, Aberfeldy, Perthshire, PH15 2ET, Scotland.

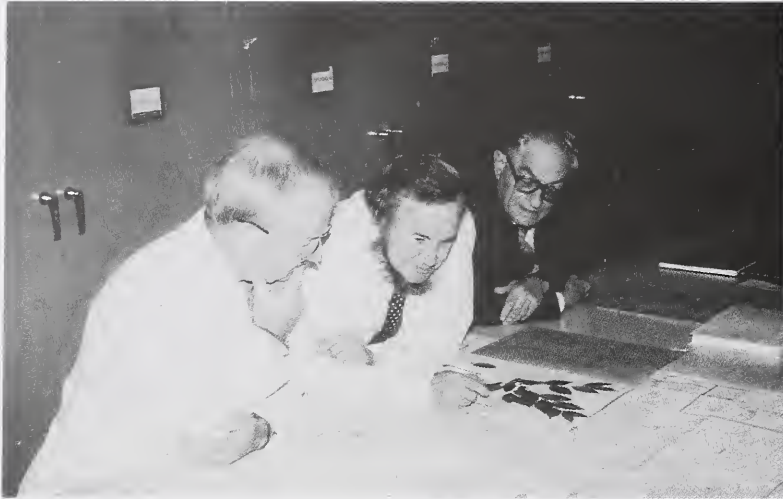


FIGURE 2.—White at work with P. Bamps and J. Léonard in the herbarium of the Jardin Botanique in Brussels, 1986. (Photo by J. Léonard).

Chrysobalanaceae, and Meliaceae, and the forest floras of Northern Rhodesia (Zambia) and Malawi. His work in orthodox taxonomy, by himself and in collaboration with others, resulted in the description of one new genus, 59 new species, and 27 new subspecies. These together with 91 new combinations and other taxonomic categories make a total of 210 taxa covering 12 families associated with his name. (Information supplied by S.K. Mamer courtesy of Index Kewensis CD ROM). Later he became renowned principally for his studies in the fields of phytogeography, chorology, and cartography of the vegetation of the whole of Africa. To quote his AETFAT colleague, J. Léonard (1995), 'il aura marqué la phytogéographie de l'Afrique d'une empreinte originale et indélébile' (Figure 2).

He was a stalwart protagonist of AETFAT (Association pour l'Étude Taxonomique de la Flore d'Afrique Tropicale), of which he was a founder member and which played a big role in his life. He attended its first plenary meeting in Brussels in 1951, and most of the subsequent general assemblies. At the 5th Assembly in Sept. 1963 in Italy, he became secretary of a committee of seven (Aubréville, Barbosa, Codd, Duvigneaud, Pichi-Sermolli, White and Wild) charged with the compilation of a vegetation map to replace the more concise earlier map of Keay (1959). The next twenty years were devoted primarily to this work (Figure 3). Before publication the map was tested in the field by many experienced AETFAT members, but chiefly by White himself. The finished map, with its 365-page memoir, was a brilliant synthesis and earned great acclaim. It was reviewed by J. Léonard (1984), and translated into French by P. Bamps in 1986.

White derived great inspiration and help from the AETFAT fraternity. He in turn enriched its work by his own considerable genius. Léonard (1995) has said that 'working on his own in relative isolation at Oxford, he realized early that works of great breadth, like those with which he became involved, could only be successfully completed with the help of numerous specialists such as are to be found within the great family of AETFAT'.

White was an original thinker. Take for example his treatment of those very variable species which defy classification because of lack of correlation of characters, a classic example being *Diospyros mespiliformis* (White 1962b). He coined the term 'ochlopecies' to accommodate them, and this term has been taken up by taxonomists around the world.

In the field of phytogeography he devoted much of this thinking to chorology. In current usage it is the study of the *distribution* of taxa and phytochoria and their *histories*. In his memoir (White 1983c) he outlined a new conception of African chorology. The system he used for the Vegetation Map was concerned with the most widely used category, the *region* (see his definition, White 1976a, 1979c), which in previous systems had been characterised mainly by endemic families and genera. But in his opinion the distribution of species provides a more objective classification. He always emphasised the interdependence of taxonomy, ecology and chorology which, he maintained, should always be studied together, and he proposed his now famous general and chorological aphorisms which he said all botanists should bear constantly in mind (White 1971).

He believed in studying the plants in the field, and to that end he travelled widely and collected extensively in Morocco, Nigeria, Cameroun, Niger, Kenya, Zambia, Malawi, South Africa and Zanzibar (Figure 4). His travel notes, contained in ten documents entitled '*Iter africanum*' totalling 3 000 pages of typescript (see Bibliography), and his collections which run into the 14 000s, give some indication of his work rate in the field (information supplied by A.M. Strugnell of the Daubeny Herbarium, Oxford).

His thinking on the role of perception (or 'intuitive discernment') is worth noting (White 1993b). He talks about perception being 'based on the capacity of the human eye and mind to detect patterns in large amounts of visual and factual data, before they have been consciously analysed'. 'Perception', he said should be based on 'wide experience, a critical outlook, the possession of a good eye and a good memory'. All these qualities he had him-

self in good measure (Figures 5 & 6). Chapman was witness to his powers of observation in the field. ‘On one very brief visit to the Misuku Forests (Malawi), he found *Alangium chinense*, a first record for these forests, an elusive tree which I had failed to discover. A few weeks later on Mt Mulanje he spotted *Olea*

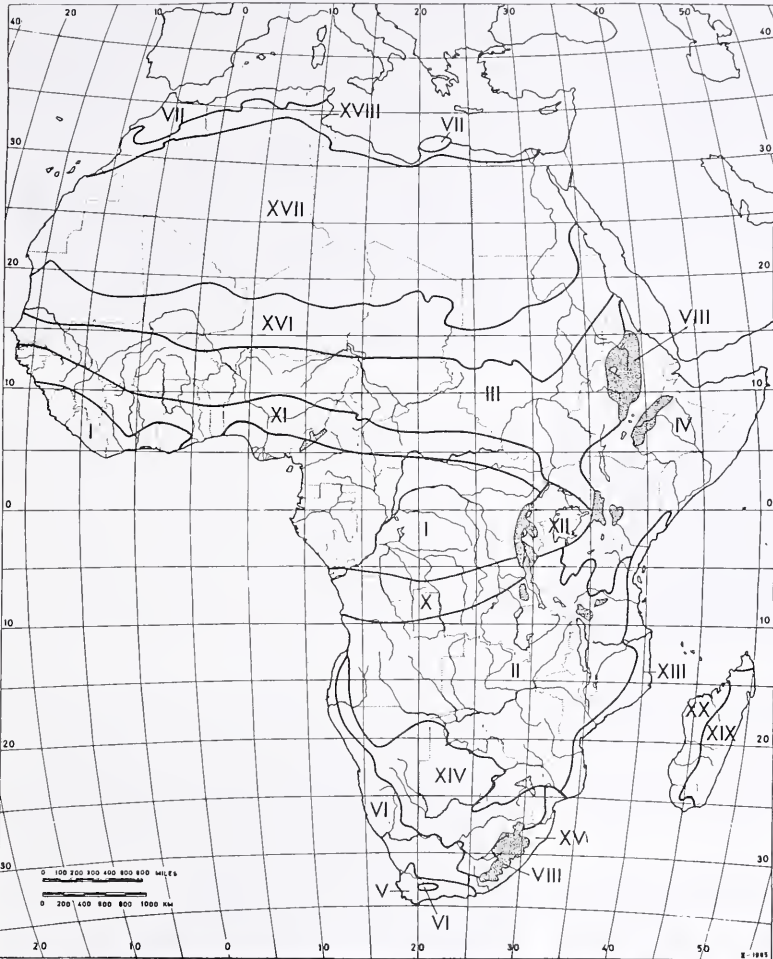


FIGURE 3.—White’s map of regional phytocoria of Africa and Madagascar (from White 1993: 237).



FIGURE 4.—White, left, at work on his collections in camp, with forestry officer W.D. Holmes, Mwinilunga District, Zambia, 1952. (Photo by A. Angus).



FIGURE 5.—Frank White, doyen of 20th century African forest botanists, observing the Chinzama cedars, *Widdringtonia whytei* Rendle, Mt Mulanje, Malawi, May 1981, (Photo. by J. Chapman).

europaea subsp. *africana*, the only record for Malawi south of the Viphya plateau’.

One of his last accomplishments was the masterly résumé of his ideas and methods, expounded over the years in diverse publications, which he was asked to write by his AETFAT colleagues in Brussels (White 1993). Léonard & Bamps (1995) note that he entitled it ‘par modestie’, ‘The AETFAT Chorological Classification of Africa’. This paper is a fitting finale to his writings which were always of high quality and always bore the stamp of scholarship.

Aside from his research, White was an excellent teacher. He also ran the two big Oxford herbaria from 1971. Many of his students, now dispersed throughout the world, continue to study plants inspired by his example and using his methods (Figure 7).

The man

One might imagine from the above account of White’s work that he must have been a very serious fellow totally absorbed by his specimens, books and manuscripts. Far from it. He had a lively sense of humour. He enjoyed laughter and making laughter. A connoisseur of food and drink, he was also an accomplished cook. A generous host, his hospitality became legendary. There was always a firkin of ale

tapped ready to refresh visitors to his cottage in Taston which he appropriately called ‘Firkins’ (Figure 8).

He was an intellectual with the common touch, equally at home in the pub chatting with the locals as in the rooms and corridors of the University. An eccentric, in the sense of not conforming to the ordinary rules of behaviour, his idiosyncracies could sometimes amuse, sometimes irritate. For example he would, on occasion, work late into the night and sleep well into the morning. He often ignored public holidays. Angus remembers that on a visit to the Mt Makulu Research Station in Zambia, on Christmas Day he took no part in the general festivities except to eat his Christmas dinner. Most of the day was spent collecting and writing notes, and he would not be diverted from that which he considered to be making the best use of his time. Chapman recalls his emphatic refusal to take a daily walk in Zomba in 1981, to prepare for the arduous climb up Mt Mulanje. His time was too precious.

He was a renowned spinner of yarns, and many of his tales are remembered and retold by his students and colleagues. One of the better known anecdotes tells of him being chased by an ostrich while riding a motor-scooter in South Africa. Angus remembers his special brand of ‘herbarium humour’. We had numerous botanical swear words and occasionally one might hear an oath ringing through the herbarium—words like *Hel-i-chrysum* or *Sphc-damn-ocarpus*. The reader will be able to think of others! We invented common names for African plants, such as ‘hedgehog with lifebelt’ for *Pterocarpus angolensis*.



FIGURE 6.—White outside the Chinzama hut, Mt Mulanje, May 1981. The tree is *Widdringtonia whytei* (L.) Radlk. (Photo. by J. Chapman).



FIGURE 7.—White, Oxford University archive photograph, giving a student seminar, 1984.

sis. The tag 'indet., mat. insuff.' (not identified, material insufficient), sometimes necessarily applied to specimens sent for identification, often meant for him 'not identifiable, material insufferable'.

Although a bachelor, Frank liked women, and got on well with them. And they liked him. Chapman remembers hearing how popular he was with the girl students at the University of Cape Town. 'His attraction for the ladies had not diminished 28 years later. On one trip to the Lichenya Forest Reserve near the foot of Mt Mulanje in Malawi we were accompanied by a number of tea estate and other botanically-inclined ladies. Frank obviously

held their attention, and this was clearly not only because of his red straw hat which they all greatly admired'. And in his work he had much fruitful collaboration with women, notably in the role of botanical artist; but also as co-workers and co-authors in research. Special mention should be made of Françoise Dowsett-Lemaire, a Belgian zoologist with a flair for botany. He first met her in 1981 in Malawi and with Chapman they collaborated on the flora of Malawi until his death. Through her continuing efforts this major work will be published. A special friendship developed between them, and during her frequent stays at his home in Taston, in the last difficult years of his life, she was a great help to him in the mundane but necessary affairs of life such as shopping and cooking. She has said of him (pers. comm.) that 'he formed me as a taxonomist' and she remembers him 'above all, as wonderful, affectionate friend'.

We who knew him well shall always remember his laugh, his upright bearing and striding gait (he was a great walker), and his twinkling eyes. Chapman's wife mentioned his 'twinkly eyes' in her diary, after that first meeting with him at the foot of the Mafinga Mts in 1952. That 'twinkle' remained with him always and was a natural expression of his great intelligence and sense of humour.

Sir Ghilleen Prance, one of his most distinguished students has said with truth in the Funeral Oration, that 'those who knew Frank only for the last ten years of his life did not know the true Frank White, because he struggled so hard with illness that made him at times impatient, intolerant or outspoken. Underneath was a brave fight to continue his work in which he succeeded well'. We mourn the passing of a botanist of great erudition and independent mind, but more than that, a fine colleague and a loyal friend.

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FIGURE 8.—White by his cottage, 'Firkins', early 1970s. (Photo. by A. Angus).

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A Frank White Memorial Symposium on Floral Diversity in Africa and Madagascar, arranged jointly by the Royal Botanic Gardens, Kew and the Linnean Society of London, will take place at the Department of Plant Sciences, University of Oxford on 26 and 27 September 1996. Topics will include: chorology, vegetation structure and diversity, plant adaptation, animal interactions, taxonomic complexities and application of botanical information. Sir Ghilleen Prance will introduce the meeting and speakers will include I. Friis, P. Morat, M.J.A. Werger, P. Lowry, R.M. Polhill, J.M. Lock, F. Dowsett-Lemaire, C.E.G. Tutin, Q.C.B. Cronk, M.H.P. Jebb, D. Harris and D.F. Cutler. Caroline Pannell will speak on Frank White's scientific achievements.

OBITUARIES

ARTHUR KOELEMAN (1915–1994)

Mr Arthur (At) Koeleman (Figure 1), succulent enthusiast and pioneer breeder of aloes, died on 17 July 1994 at the age of 79 from complications brought on by chronic emphysema. 'Oom At', as he was affectionately known, was born on 14 February 1915 in the district Lydenburg in the Transvaal Province, now part of Mpumalanga. After matriculating from the Lydenburg Secondary School in 1932, he studied at the Normaalkollege in Pretoria and was awarded the Transvaal Teacher's Diploma at the end of 1935. In 1936 Oom At started his teaching career in Carolina, but at the end of the first term he was transferred to Blyde and in 1937 to Linden in Johannesburg. Owing to poor health, he was granted special leave and returned to his parents' home in Sabie, where he worked for a short time at the Glen Lydenburg Mine. After regaining his strength, Oom At returned to teaching and subsequently held various teaching positions, amongst others at the Wonderboom-Suid Primary and the Langenhoven Secondary Schools in Pretoria.

In 1968, at the age of 53, he continued his tertiary education and one year later obtained a B.Sc. degree from the University of Pretoria with Botany and Genetics as majors. A cartoon by L.N. Nel depicting Oom At 'back to school', characteristically with a cigarette in one hand, was published in the journal of the South African Succulent Society, *Aloe* 6,1: 21, January–March 1968 (Figure 2). He then taught again for one year and eventually retired from the teaching profession at the end of 1970. He worked for the Department of Nature Conservation of the Transvaal Provincial Administration in Pretoria (now part of Gauteng) during 1972, at the same time registering for a B.Sc. (Honours) degree in Botany. In 1973, the year during which the degree was bestowed on him by the University of Pretoria, he took up a position as Technical Assistant (Horticulturist) in the botanical garden of the Department of Botany at the same university. He held this position from 1 July 1973 to 30 June 1980. Oom At started his research for a master's degree in Botany in 1973 under Profs P.J. Robbertse and A. Eicker, and on 6 April 1979 an M.Sc. (botany) was conferred on him for a thesis entitled: 'n Morfologies-taksonomiese studie van die blare van die genus *Encephalartos* Lehm. in Suid-Afrika (English: A morphologic-taxonomical study of the leaves of the genus *Encephalartos* Lehm. in South Africa).

In 1950 Oom At bought Plot 29, Hartebeeshoek, a smallholding on the northern slopes of the Magaliesberg north of Pretoria, where he stayed up to the time of his death. Here he started to grow succulents, particularly members of the genus *Aloe*. His growing interest in this genus became a source of great pleasure and an absorbing pastime. He systematically started to hybridize various *Aloe* species and what started as a hobby, eventually developed into a full-scale research nursery. It is for this pioneering work on the hybridization and improvement of aloes that Oom At will probably be best remembered (Irish 1993; Koeleman 1962, 1965). Not only was he one

of the founder members of the South African Aloe and Succulent Society (now the Succulent Society of South Africa) in 1962, but he was also instrumental in establishing the South African Aloe Breeders' Association in May 1973 (Bezuidenhout 1982; De Wet 1982a, b). Some of the earlier volumes of the journal *Aloe*, official mouthpiece of the South African Succulent Society, carried descriptions of numerous new *Aloe* cultivars developed, amongst others, by Oom At; the vouchers for these were almost exclusively deposited in the National Herbarium (PRE) in Pretoria. In fact, these were the first cultivars of any plant group to have been registered in South Africa (De Bruyn 1972). Oom At was also one of the first researchers to establish and refine methods for multiplying species of *Aloe*, *Agave* and *Haworthia* by means of tissue culture (Groenewald, Koeleman & Wessels 1975, 1979; Groenewald, Wessels & Koeleman 1975, 1976a, b, 1977; Wessels, Groenewald & Koeleman 1976). Other novel vegetative techniques, about which Oom At was very secretive, were used to multiply those hybrids registered as cultivars. In later years he also did pioneering work on the use of tissue culture methods for the propagation of species of the cycad genus *Encephalartos* (Koeleman & Small 1982). In addition to his active role in succulent plant studies, Oom At was for many years chairman of the South African Aloe and Succulent Society and editor of its journal *Aloe*. He was subsequently elected as one of the honorary vice-presidents of the society, and maintained an active interest in the hybridization, selection and propagation of species of *Aloe* up to the time of his death in 1994.



FIGURE 1.—Arthur Koeleman (1915–1994). Photograph taken ± 1980.

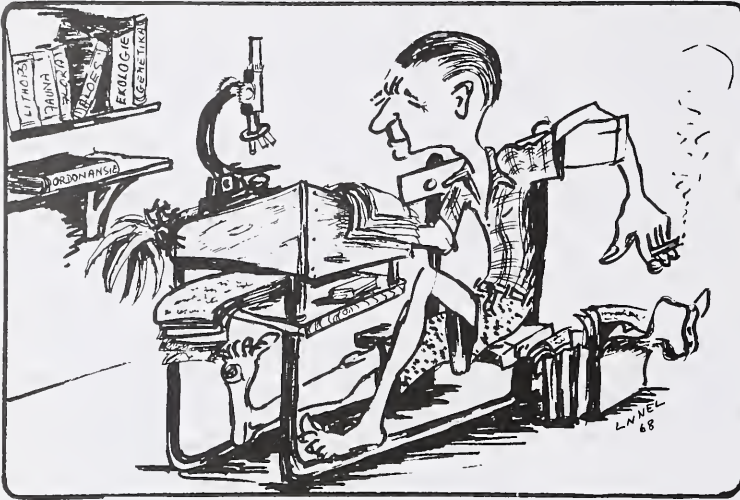


FIGURE 2.—A cartoon of Oom At Koeleman after he resumed his graduate studies at the age of 53. The original caption, translated from Afrikaans, reads 'We hear that our chairman is back on the school bench. All success Oom At.' Reproduced with the kind permission of the editorial board of *Aloe*.

In a sense Oom At was ahead of his times in that he realized the immense horticultural potential of the South African flora, and in particular of the genus *Aloe*, many decades ago. Today most local botanists appreciate the potential of our rich botanical heritage for, amongst others, breeding superior cultivars for the commercial market. But, at the time, Oom At must have been regarded as something of an aloë crank. Sadly, he was often the victim of unfounded and malevolent criticism (see for example De Bruyn 1972). Not surprisingly, during his lifetime Oom At received very little recognition for his work on the cultivation and breeding of aloes. The only response he received on a joint paper on the control of aloë snout beetles (Koeleman & De Wet 1986), was a letter from a farmer in the Karoo enquiring where such beetles could be obtained for use as a means of eradicating aloes from his farm (pers. comm. to G.F. Smith)!! His inability to enthuse some of his fellow South Africans about the horticultural and other values of the genus *Aloe* clearly disillusioned him. This is perhaps best illustrated by the fact that he told the first author and Prof. Ben-Erik van Wyk of the Department of Botany at the Rand Afrikaans University, during a visit to his nursery, Magaliesberg Navorsingskwekery, that he had destroyed most of his notes on and records of his crossing experiments in *Aloe*. A great pity, indeed. Fortunately, at least some of his cultivars are still being grown at the Pretoria National Botanical Garden and at the Lowveld National Botanical Garden in Nelspruit, Mpumalanga, and in the private gardens of a few succulent enthusiasts.

Oom At was a gentle, calm, soft-spoken and unassuming man of great integrity. Never forward or self-seeking in the progress with his research, he was nevertheless zealous and resolute in achieving the goals which he set himself and would strongly defend any views he believed were correct. Oom At could be carried away by the splendour of the *Aloe* hybrids he created, and new flowers were always awaited with considerable anticipation. He was a friendly and helpful man, always willing to share his knowledge and inspiring enthusiasm with those who showed interest in his work. As a trained teacher, the youth were close to Oom At's heart and, as can be seen

from his inspiring writings in past issues of *Aloe*, he always tried to instill in young people a love and appreciation for our succulent flora. On a lighter note, Oom At was very fond of reading 'cowboy stories', and many an evening he would retire with a soft cover 'noveltjie' and a plate of oranges, one of his favourite fruit.

On 8 January 1944 Oom At married Maria Magdalena Johanna Bezuidenhout (born 18 April 1917 at Kathu in the Northern Cape). Tannie Rie, as she was familiarly known, was Oom At's lifelong companion. An elegant lady with a beautiful, sparkling personality, she fully supported Oom At in his work and often assisted with the task of cross-pollinating the *Aloe* plants. Tannie Rie is commemorated in *Aloe* 'Ria Koeleman' [a hybrid between the Madagascan *A. capitata* Baker (variety unknown) and the southern African *A. maculata* All.], a cultivar bred by Oom At (Koeleman 1971). Despite setbacks in health experienced by both, they greatly assisted each other during their last years together. Tannie Rie passed away on 1 April 1993. The couple had no children.

It was Oom At's longstanding ambition to submit his work on the breeding of aloes for a doctoral degree at a university. Unfortunately this ideal was not to be realized. Arthur Koeleman will, however, long be honoured as the man who pioneered the breeding and improvement of *Aloe*. He was a man with foresight, and his life was an inspiring model of what can be achieved through dedication, enthusiasm and hard work. He is fittingly commemorated in *Aloe* 'Oom At', a handsome cultivar bred by Mr Gawie Dednam from a cross between *A. reitzii* Reynolds and *A. arborescens* Mill. Oom At will be remembered with affection and respect by all those who knew him.

ACKNOWLEDGEMENTS

Mmes M. Dednam, B. Bezuidenhout, M.S. Nel and Miss M. Nel and Mr Kotie Retief are thanked for providing information.

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G.F. SMITH* and A.E. VAN WYK**

* Plant Systematics Research Subdirector, National Botanical Institute, Private Bag X101, Pretoria 0001.

** H.G.W.J. Schweickardt Herbarium, Department of Botany, University of Pretoria, Pretoria 0002.

WERNER BAHNE GEORG JACOBSEN (1909–1995)

Werner Jacobsen, 'Doc' or 'Pop', as he was known to colleagues and family, was born on 6 December 1909 in Berlin, Germany (Figure 3). His schooling was completed at the Humanistisches Gymnasium in Fürstenwalde, Berlin in 1927, where he was taught classical as well as modern languages, mathematics and science. His studies continued at the Universities of Berlin, Graz, Leoben (Austria) and Munich, wherever the most renowned professors in their respective fields were tutoring at the time. He majored in Botany, Geology and Chemistry in 1931. Unable to find employment in the botanical field, which was his first love, he chose a career in geology.

In 1932 his father, an architect, emigrated to South Africa in search of greener pastures and settled in Cape Town where he designed and constructed houses. Here Werner was at home among the mountains which reminded him of the Alps in which he had hiked and climbed during his student years, and he collected some 1 000 specimens of plants for his private herbarium. He obtained employment with the Anglo-American Corporation as Assistant Geologist from 1932–1938. He was part of the team which was instrumental in the discovery of the Western Reefs Mine in the North-West (western Transvaal). Subsequent to his marriage to Beatrice Cutts in 1936 he was seconded to the so-called Bancroft Circus for a year, prospecting in what was then Nyasaland (Malawi), where he was nearly killed by a wounded buffalo. Werner, accompanied by his family which by now included a son, Jens, returned to Germany in 1939 to write up his doctoral thesis on the geology of the Ventersdorp System entitled 'Tektonik und Lithogenese der Venters-

dorp Formation im Klerksdorp—Wolmaransstad Distrikt des südwestlichen Transvaal und im nordwestlichen Oranje-Freistaat', obtaining his degree with distinction.



FIGURE 3.—Werner Bahne Georg Jacobsen (1909–1995).

Unfortunately his timing placed him in the path of the oncoming conflict of the Second World War and he was drafted into service spending most of the war years working for the Reichsamt für Bodenforschung in Norway, in the Balkans and in Russia. After the retreat of German forces from Russia he surrendered to the American forces on crossing the Elbe River into what became known as West Germany. As a prisoner of war his linguistic ability led to his appointment as interpreter to the Allied Forces.

In 1949 he returned to South Africa to rejoin his family which now included a second son, Niels. They had managed to return to South Africa the year before. Here he worked as a consultant geologist until 1955, when he joined the Messina Transvaal Development Corporation and moved to Mangula (now Mhangura) in Southern Rhodesia (Zimbabwe). He was resident geologist on the local mine for the next 15 years. During this time he was able to indulge his first love, studying the plants of copper-rich anomalies. This activity resulted in three papers on the subject (Jacobsen 1968a, b, 1970). At the same time he made a collection of the flora of the area which resulted in another publication (Jacobsen 1973).

In 1970 he moved back to South Africa, working from the headquarters of the Messina Corporation in Johannesburg, visiting prospective claims in Namibia and Natal as well as Zimbabwe until his retirement at the age of 68. Throughout this time he collected ferns wherever he went, particularly during holidays when he could visit specific fern-rich areas, which resulted in a paper on the subject (Jacobsen 1978). His retirement meant that he was now free to fulfil his ideal of working on plants, and on ferns in particular. He attempted to obtain a post at the then Botanical Research Institute but, much to his disappointment, he was unsuccessful due to a lack of funds. He now concentrated his efforts on writing a book on the southern African ferns, of which he had collected many specimens during his working years. At the same time he also had the collection of the National Herbarium at his disposal. This work resulted in the *Ferns and fern allies of southern Africa* (1983) which was the first treatise on this subject since T.R. Sim's (1914), *Ferns of South Africa*. This was followed by several publications on the taxonomy and distribution of ferns (Jacobsen 1991; Jacobsen & Jacobsen 1985, 1986, 1988a, b, 1989).

During his later years, his health was gradually eroding his ability to move about. This resulted in 'Pop' spending most of his time working at his desk on geographical and other aspects, including the growth of human populations, shipwrecks around the South African coast, mythological and clerical figures and a host of other topics. His knowledge of Greek and Latin made it possible for him to compile a 600 page manuscript (unpublished) on the derivations of plant names of the flora of Namibia. His general and scientific knowledge was exceptional. He was always

the perfect gentleman, a patient teacher to his sons and to all who worked with him, in many instances encouraging his staff to further their studies. He was loved and respected by all his colleagues. During his retirement he also presented a series of lectures on ferns to the Witwatersrand University Botany honours class, and he wrote articles on ferns in the newsletters of the SWA Scientific Society.

Although specialising in ferns in his later years, 'Pop' collected about 4 500 plant specimens, mostly from Zimbabwe and South Africa but also from Mozambique, which are deposited in the National Herbarium, Zimbabwe, the National Herbarium, Pretoria and the Senckenberg Herbarium, Germany. The 1 000 specimens collected in the Cape in 1932 were destroyed by fire in Germany during the war.

'Pop' died in his sleep in a Pretoria hospital after a short illness on the morning of the 24th October 1995.

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N.H.G. JACOBSEN* and J.B.E. JACOBSEN

* P.O. Box 49193, Hercules, Pretoria 0030.

Book Review

AUSTRALIAN VEGETATION, 2nd edn, edited by R.H. Groves. 1994. *Cambridge University Press*, The Pitt Building, Trumpington St, Cambridge CB2 1RP. Pp XVIII + 562. Price: hard cover, £50; paperback, £17.95.

The second edition of this well-known publication is, like its predecessor, designed to be 'a reasonably concise book on Australian vegetation' to quote its editor, R.H. Groves. It is just that, but also incorporates new research data published during the 12 years that have elapsed since the appearance of the 1st edition.

This book is not a descriptive account of all Australian vegetation types at community level. For such data one should consult Noel Beadle's *The vegetation of Australia* (Cambridge 1981). *Australian vegetation* on the other hand deals more with the dynamics, ecology and biology of the principal vegetation types found in Australia.

There are some 18 chapters each prepared by a specialist in their field. After an introduction dealing with phytogeography in the Australian

region, Quaternary vegetation history and a short overview on alien species, the bulk of the book is devoted to accounts of the major vegetation types followed by chapters on extreme habitats such as coastal dunes, salt marshes and mangroves, inland wetlands and alpine habitats. Some of these chapters are specifically devoted to those peculiarly Australian features, e.g. *Acacia* woodlands, shrublands and open forests, and *Eucalyptus* forests and shrublands. Each chapter concludes with an ample list of relevant references. R.L. Specht rounds off the book with an excellent chapter on biodiversity and conservation.

This is an elegantly produced high quality publication in a robust binding, amply illustrated with diagrams and clear halftone plates. As a general overview of the subject it would be hard to beat. Regrettably the hard covered version at £50 sterling (nearly R300) is probably beyond the means of impoverished South African academics. A paperback edition at £17.95 is apparently only available in Australia.

J.P. ROURKE

BOTHALIA

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Abstracted, indexed or listed in • AETFAT Index • AGRICOLA • BIOSIS: *Biological Abstracts/RRM* • CAB: *Herbage Abstracts, Field Crop Abstracts* • CABS: *Current Advances in Plant Science* • ISI: *Current Contents, Scisearch, Research Alert* • *Kew Record of Taxonomic Literature* • Taxon: Reviews and notices.

ISSN 0006 8241

© Published by and obtainable from: National Botanical Institute, Private Bag X101, Pretoria 0001, South Africa. Typesetting and page layout: S.S. Brink (NBI). Reproduction and printing: Aurora Printers, P.O. Box 422, Pretoria 0001. Tel. (012) 327-5073.